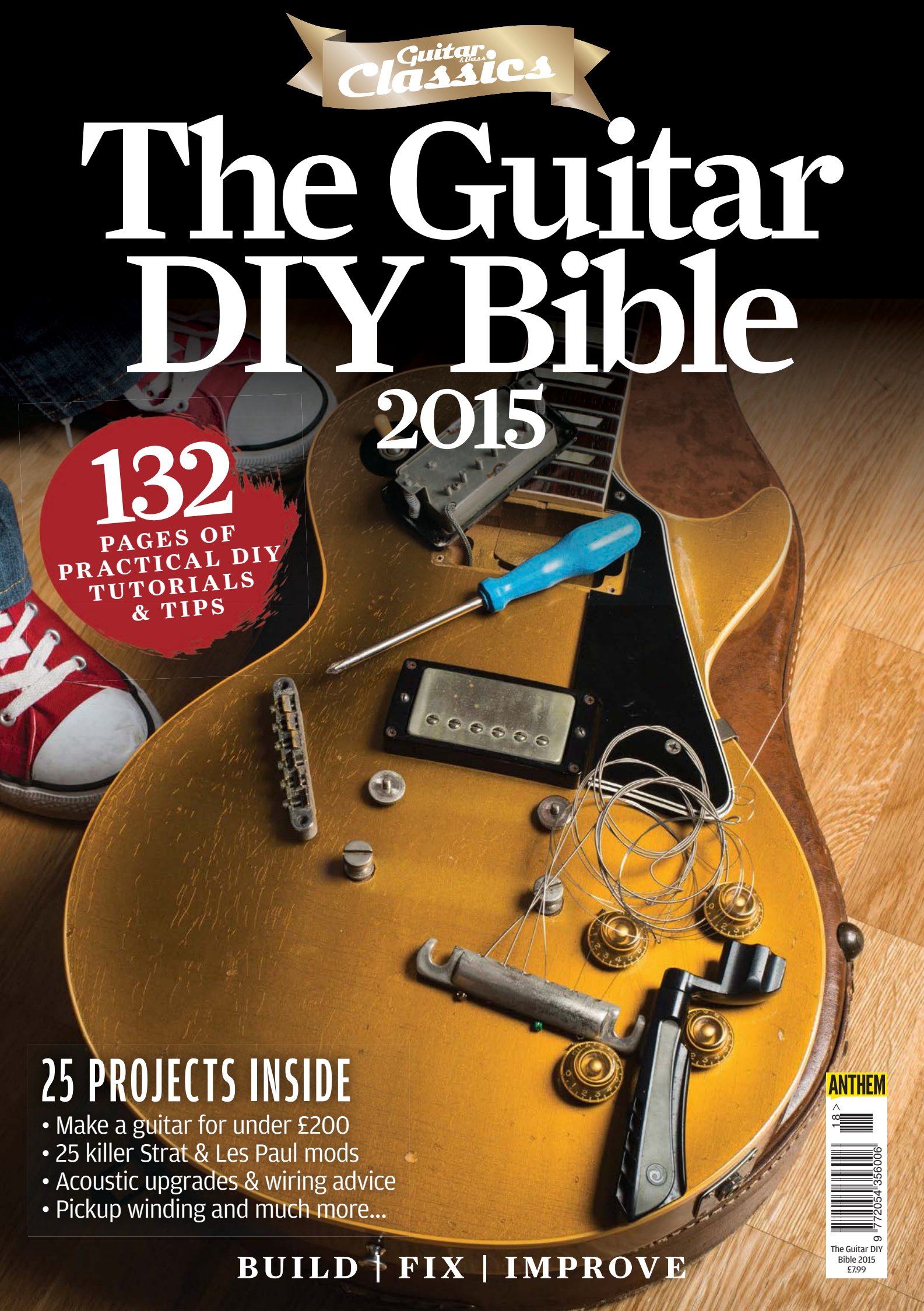
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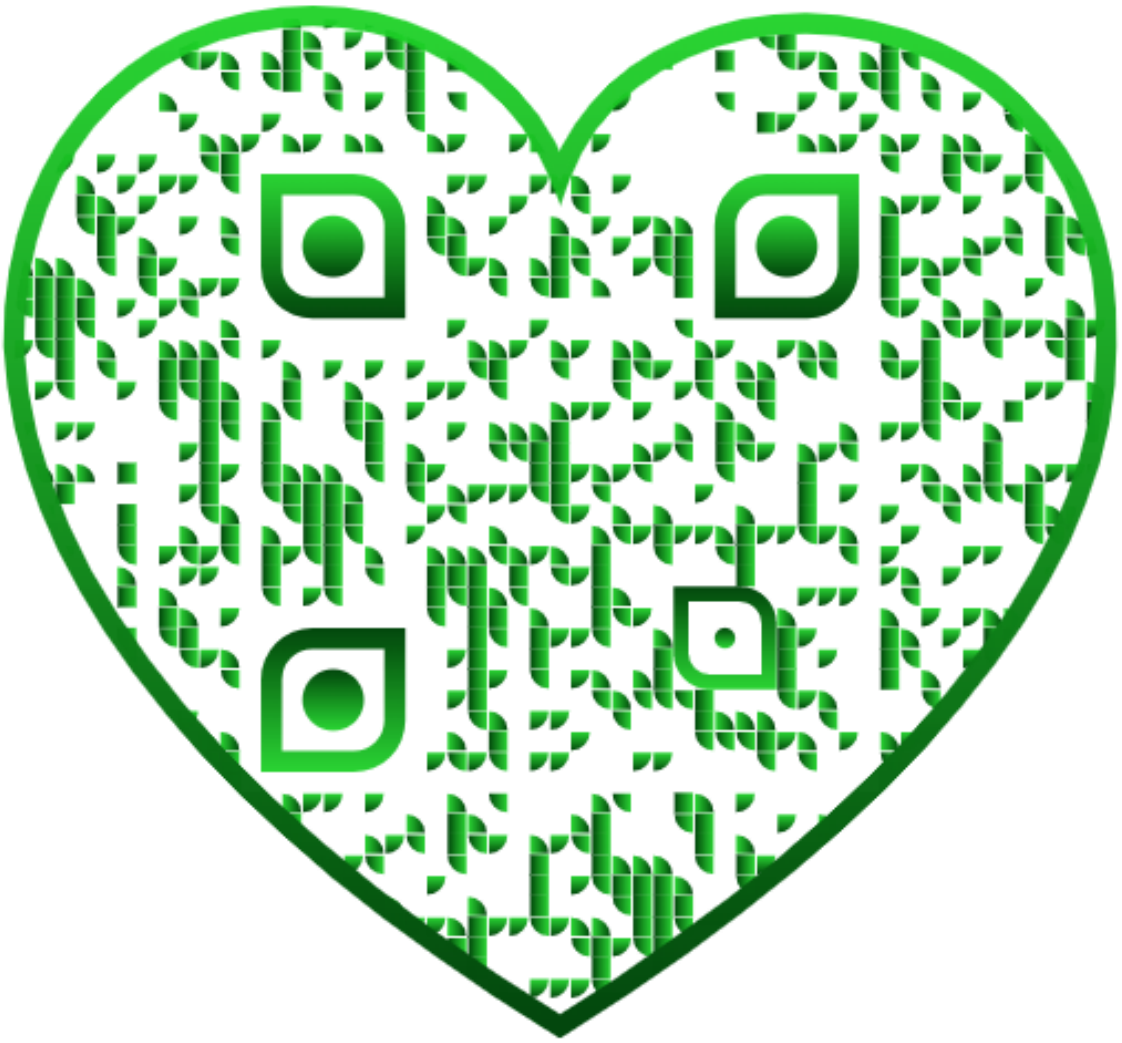

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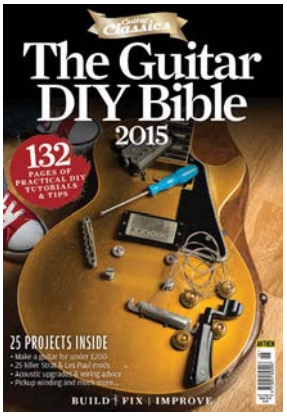
WELCOME

Can you fix it? Yes you can...

I'll be the first to admit that my early experiments in guitar maintenance were less than successful. For a start, my 11-year-old self thought that the bridge saddles on my Squier Strat looked far better when adjusted so that they sat in a perfectly straight line – goodbye intonation! Then there was the matter of the upper-fret choking that I thought I'd be able to solve with a claw hammer... the less said about that the better. Happily, I'm not quite as inept these days, thanks in no small part to the wealth of knowledge that fellow guitar journalists have been willing to share over the years, both anecdotally and in the pages of G&B.

If you're not afraid to wield a soldering iron or other basic tools, then there's plenty of potential, not just to simply maintain your instrument but to improve it, too. Across the following pages, we present an extensive guide to doing-it-yourself that'll help keep your prized instruments and amps ship-shape, and we even show you how to build new toys from scratch. As always, proceed with caution and stay safe, but most importantly have fun! If you attempt any of these projects we'd love to see the results so please do send us pictures of your creations either via email guitarandbass@anthem-publishing.com or facebook.com/TheGuitarMagazine – you might even see your work featured in the magazine! Good luck, and don't forget to pick up a copy of the mag every month for plenty more DIY Workshops where these came from...



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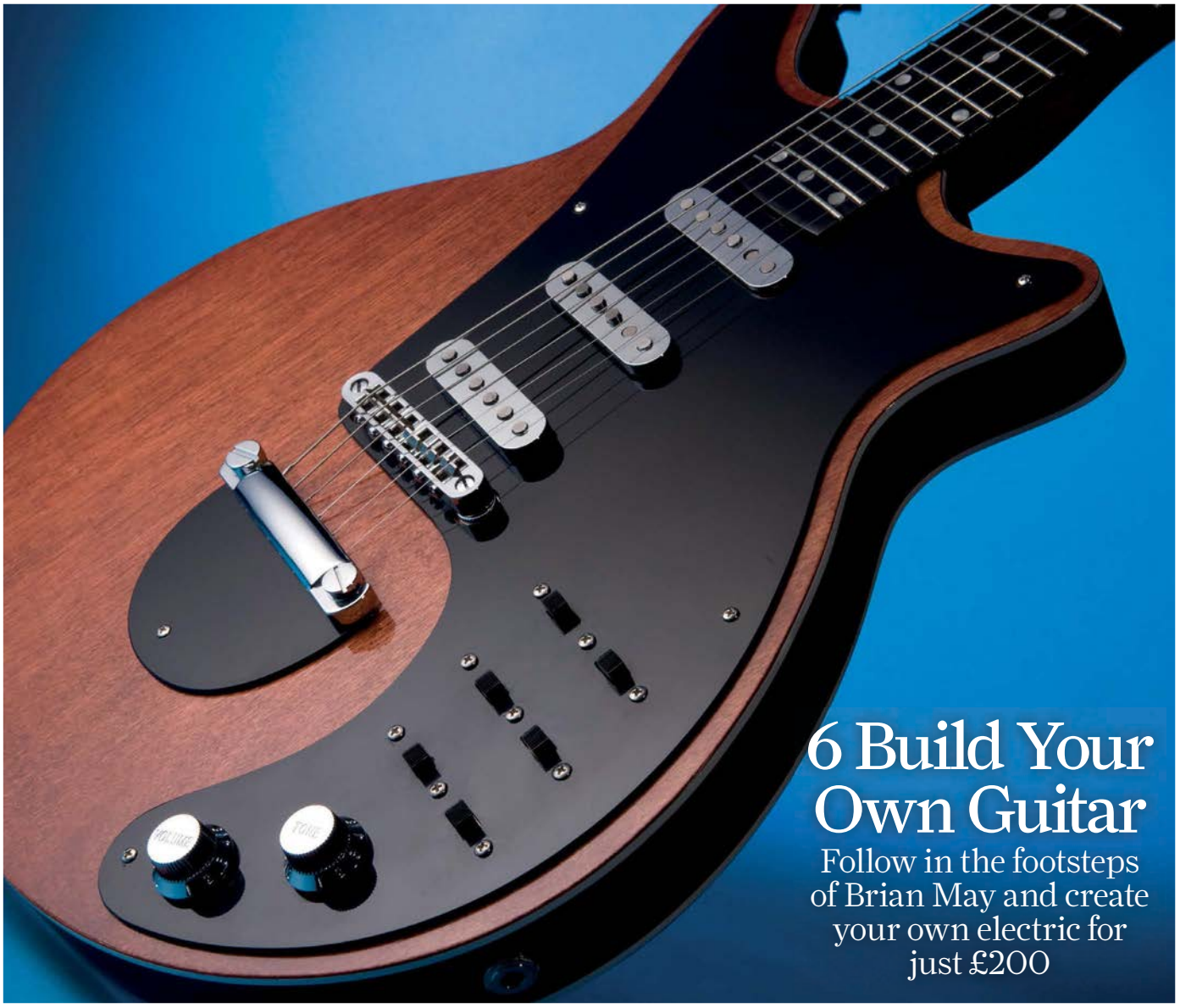
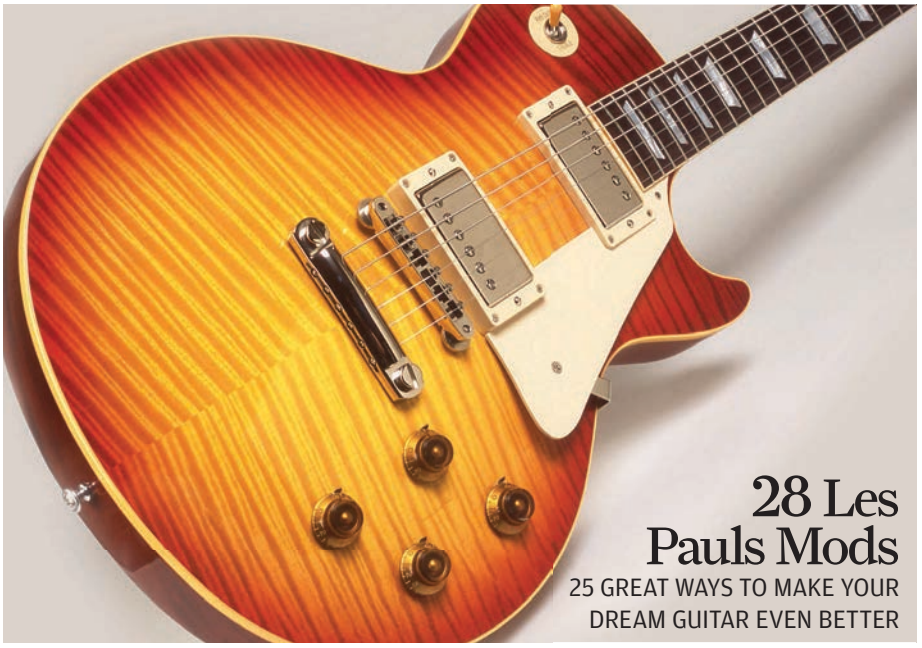


6 Build Your Own Guitar

Follow in the footsteps of Brian May and create your own electric for just £200



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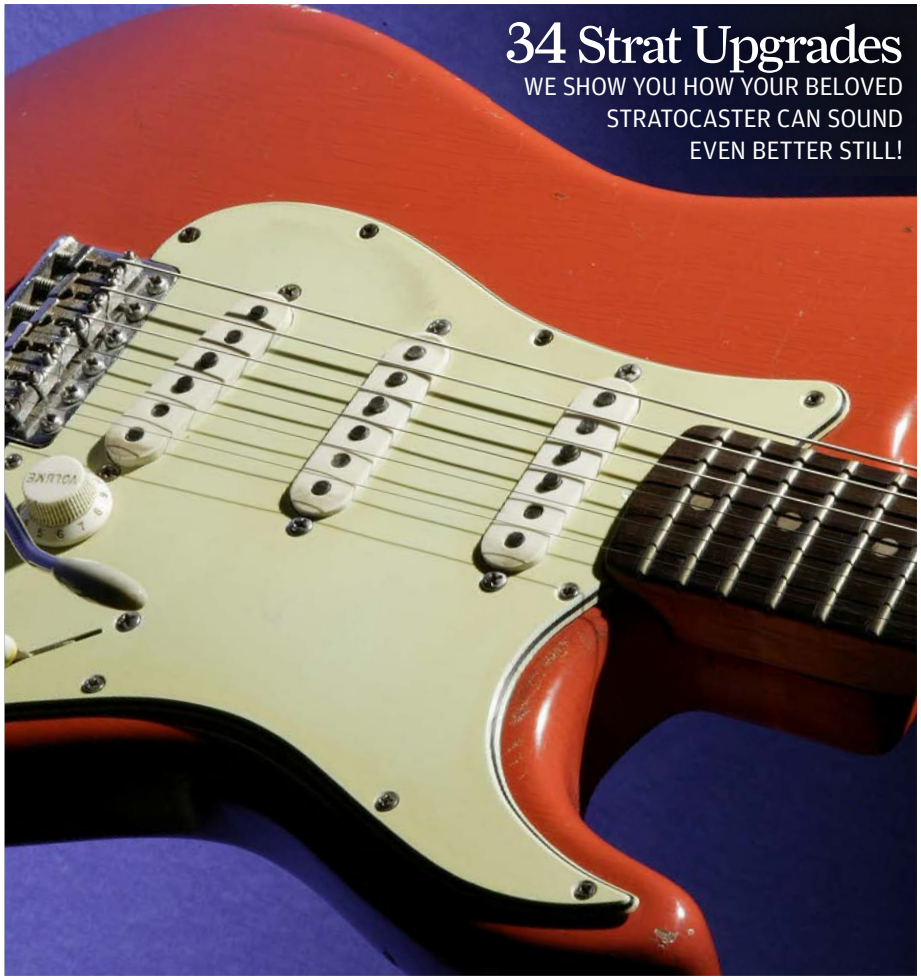

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Brian May's Red Special

Main photo: Mike Prior Insert: Brian May by Chris Walter/WireImage/Getty images

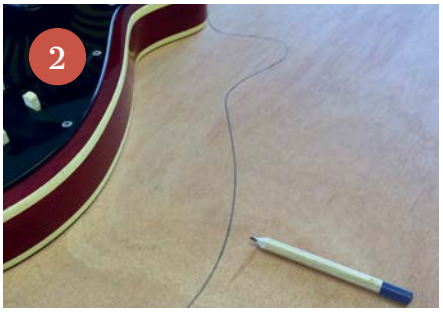
Code Red

Can you travel the same guitar-building road as Brian May with a budget of under £200? **DAVE WALSH** accepts the challenge, and shows us how it's done...

Brian May and his father Harold built the iconic Red Special 50 years ago using whatever they could lay their hands on for an estimated total of 10 guineas. To celebrate this anniversary, we thought it would interesting to build our own version of the guitar – not an exact copy, but an instrument that you can modify to your own tastes using these techniques in the spirit of one of the most celebrated handmade guitars ever built. We also decided to build it in under a month from start to finish.....

Clearly, building an exact replica just wasn't practical due to the complex nature of the build and also the expense of such an undertaking. So we decided to approach it from a different angle: what could be built for a miniscule budget that retained the most important elements but was simple enough to attempt at home?

Most of the tools available to a modern guitar-building workshop, we decided, would be banned: no pin routing, CNC or complex finishing techniques or materials would be used – just a few power tools and a selection of hand tools. A bandsaw was used briefly, but most of the cuts could be performed with a common or garden DIY jigsaw or, if patience allowed, a hand saw and coping saw. We did include a handheld router, but it's just a basic model that many people will hopefully have easy access to.



1 The basis for our build is a handmade tribute dating from the mid-1990s

2 Drawing the outline of the body

3 Cutting the outline with a jigsaw

4 Perfect mirror images of front and back

5 Neck will be set into these maple centre blocks

6 Beginning to glue together the layers of 12mm and 18mm MDF to make the middle sandwich

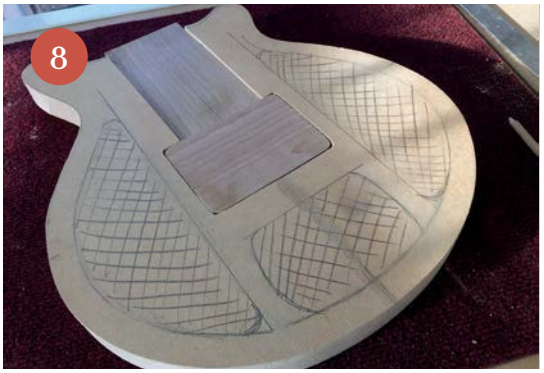
Construction Choices

The original Red Special is a semi-solid electric guitar using a chunky one-piece mahogany neck bolted into a lightweight body formed from a solid oak centre section and hollowed wings made from blockboard, with the joins disguised by veneers. The unusual 24" scale length, neck woods and tone chambers will be vital to creating a similar acoustic voice, so we're staying close – with a few budgetary modifications. A mahogany neck is essential to capture the warmth of tone associated with the RS, but the complex body would need to be slightly different. Blockboard was a common material back in the day; we'll be using MDF for the wing sections of the body because it's cheap, available and in many ways is the blockboard of today. It doesn't have great tensile strength but it doesn't matter as the MDF doesn't take any of the string tension.

Some other tough decisions were made early on, such as the choice not to fabricate or incorporate a vibrato of any sort. The original RS uses an ingenious handmade unit that rocks on a knife-edge buried beneath the guitar top and a roller bridge that was years ahead of its time. Yes, we could use a budget Strat fulcrum vibrato, but it looks totally wrong and will probably sound wrong too. A cheap vibrato is also a pain to keep in tune, so a hardtail bridge will be used. I toyed with the idea of a Tele bridge or even a one-piece wrapover unit but ultimately a good old tune-o-matic and stop tailpiece won the day. A perfectly usable pair can be bought for £20 and offer solid string anchoring and tone.

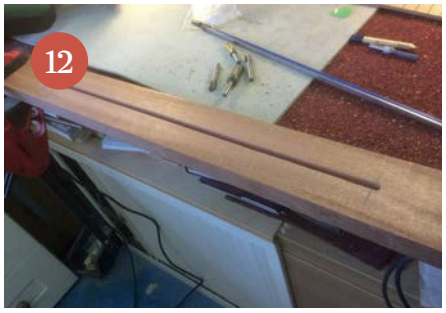
The body outline we used is close to the original, if not exact. I made a replica in the mid-'90s before any plans or templates were available online; reliable information was very scarce so I researched it as much as was possible, and had to guess the rest. Digging out my replica, I decided that the outline was close enough to use as a basis for the body.

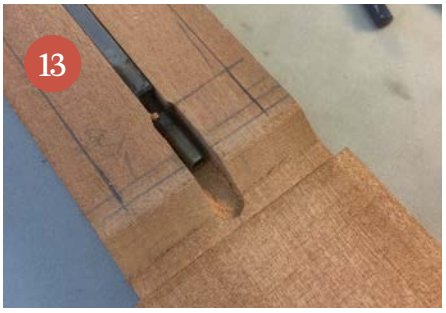
The mahogany neck would use an elongated heel join set deep into the body. A pre-squared quarter-sawn mahogany neck blank, bought online, was good quality and excellent value. The dimensions – 750mm long, 70mm wide, 25mm deep – were almost spot-on for our neck. It would leave enough length for the pointed headstock and heel to be carved from one piece. I also sourced an oak fingerboard blank that was already slotted for 24 frets with the correct 24" scale length. We could have made one but I felt that it may be too tricky to try at home without some of the specialist tools commonly used for the job, and I also selected a dual action truss rod for ease of fitting.



7 Fitting the maple sections

8 Marking out the cavities





Beginning The Body

Real guitar making usually begins with carefully making an extensive set of templates. We didn't have time for that as it's too long-winded and not really necessary to achieve a decent one-off result. After a quick nose around, a couple of small sheets of 4mm thick plywood were discovered that had once been a protective layer on a shipment of goods. A quick inspection showed that they had a pleasant reddish quality on the top layer and were thick and strong enough to act as a top and back for a semi-solid guitar. Laying my own replica on top of the sheets I traced the outline and cut the shape – one for the top and one for the back – then temporarily joined the two pieces using small pieces of double-sided tape which allow the edges to be sanded flush, leaving some extra material at the neck join area for tweaking later. Once separated again, we end up with two perfectly matched mirror image pieces that could now be used not only as a template for the centre of the body sandwich but would eventually form the actual top and back. This is the time to measure and draw the centre lines as they'll be used later for lining up the rest of the body.

Some MDF offcuts fell into our hands – a 12mm and an 18mm piece that when glued together with the plywood back and sides would form a slab. Adding in the additional 8mm thickness from the plywood gave us a total thickness of 38mm – thick enough for the body. Once dry these were also cut and trimmed to rough shape. Tip: have a nose around the timber cutting section of your local DIY store as they usually have a bin of off-cuts going cheap, and they'll be big enough for a guitar body. (Note: I did cheat and use a small bandsaw for some of this work, but a jigsaw works just as well. Don't forget to wear a mask when working with MDF as it's a carcinogenic.)

The original RS body incorporates a piece of rock-hard oak table as the central spine that the neck and wings attach too. I didn't have any oak but I did have an offcut from a maple neck blank. I decided to cut a section off and glue it together to form a narrower section to accept the eventual neck pocket; the wider end piece would give a solid section to anchor the bridge and tailpiece.

Using the centre lines that we drew earlier meant that lining up the correct position for the inserts was easy. Use the fingerboard blank and a long steel ruler to roughly mark where the bridge will go (24" from the centre of the zero fret in this instance) and position the maple blocks, then draw accurately around them. Now you just need to remove the unwanted MDF and glue in the inserts. Start by marking and drilling the corners out and then using the jigsaw trim out the excess. Cut just inside the line for safety and file and sand up to the line for a snug fit. Glue it all together using Titebond on a flat board for support and to keep it level.

Once dry we mark out and cut out the acoustic chambers. We're going for an approximation which has two large sections removed down each side of the central spine and a smaller one behind the bridge where the vibrato lives on the original. Again we mark and drill the corners and then use a jigsaw to remove the waste. It looks a little crude at this stage but some elbow grease with files and sandpaper soon clean up the cuts – a bobbin sander would have been useful, but the chambers aren't visible once the top and back are glued on. >

9 Sawing cavities

10 The completed centre slab

11 Our blank is nice and square. First, the trussrod...

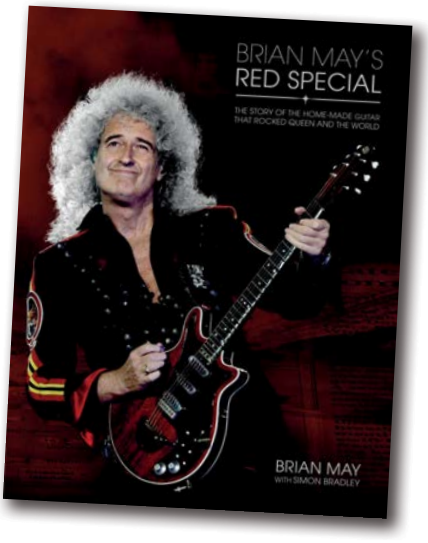
12 Routing out the trussrod channel

13 The Allen key channel needs a 9.5mm router bit

14 Gluing the fingerboard with locating pins

BRIAN'S GUITAR

The Red Special is nothing short of a work of genius. Built by Brian and his dad Harold in 1963-'64, the guitar is now 50 years old and is being celebrated in a new book published by Carlton Books, Brian May's Red Special: The Story Of The Homemade Guitar That Rocked Queen And The World. It's a fascinating insight into how the guitar was made, featuring never-before-seen images of the dismantled instrument and X-ray shots of the famous acoustic chambers. A must-have for fans of the Red Special. Out now: £19.99



15 Shaping the headstock

16 Trimming down the neck blank. A regular saw and a plane will do the job

17 Marking the tuner holes

Once we're happy that it's clean, smooth and level, we go ahead and attach the back piece of plywood. Spool clamps are useful but at a push a level surface and a few heavy books or even bricks will do the job. I used contact adhesive here as it allows for an instant and very sturdy bond.

Starting The Neck

While the body dries we can begin building the neck. We used the simplest method, which is a mix of Fender style necks, with the elongated heel mentioned earlier. The original uses a huge chunk of mahogany harvested from a fireplace with a separate oak fingerboard and a neatly carved angled headstock, but we're going to ditch the angled headstock and use the simpler Fender method of a flat un-angled headstock, all cut from the same blank.

Our 25mm deep blank is long enough to incorporate the heel and headstock in one go, but it was just too narrow at the headstock for the full width of the triangular section. Once the neck width was drawn out to 55mm at the heel it left 15mm spare which I carefully trimmed off and attached to the headstock area as small wings taken from the heel end to widen it enough to create the distinctive pointed shape.

Our neck blank was already accurately cut and square on all sides; this was the main reason for buying in a pre-shaped blank, and it's a must if you're going to rout for a truss rod channel as you wouldn't necessarily have access to the machines needed to true it up. A decent plane, some patience, a steel straight edge and a square will do the trick, unless you decide to use a real fireplace...

Again using the simplest method available, we chose a dual-action rod that sits in a flat channel 6mm wide by 10mm deep. Clamping the blank to the bench and fitting the guide to the router, we positioned the rod in the correct spot, exactly centre and leaving enough length either end for the heel and headstock. Set the router guide for the centre of the blank and rout the slot; spending a few extra minutes to line everything up accurately will allow you to not only rout it out in two or three passes but also use the clamps that hold the blank level to the bench as 'stops' for the router, ensuring a perfectly-cut truss rod slot. With the guide still attached we swap to a 9.5mm router bit and enlarge the opening for the nut access so we can slide an Allen key in easily. We'll remove most of the channel access in shaping the headstock later, but it needs to be there.

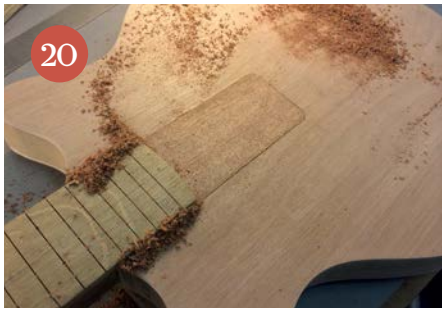
Next we measure and mark out the neck width – in this instance 47mm at the nut and 55mm at the 24th fret, which is unlike any other production neck. If you would prefer a more regular feel, mark out a 42mm nut and 56mm at the 24th fret. With these two widths measured and double-checked, you can draw straight lines between them to give the neck shape. Continue the lines to the end of the blank for the elongated heel and then trim the blank down. A regular saw and a plane will do this job but ensure that the sides are straight and square, or the neck will never feel right.

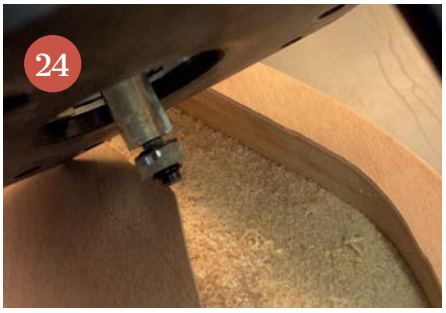
Using the truss rod channel and existing centre lines, lay the fingerboard over the neck and mark it out on the back. You can now trim the board and prep it for gluing by sanding the back flush. With the board in place we drill four pin holes, two through the first fret slot and two through the 20th fret. This allows us to clamp the board on once glued without the danger of it slipping or moving. Without these pins, your perfectly aligned pieces will slip and slide all over the place.

Remove the board with the pins in place and insert the truss rod with the flat bar section facing upwards. If the routing went to

18 Rough-shaping the inch-deep neck with a rasp

19 Neck pocket is routed for correct neck angle





plan then it should fit snugly and sit a couple of thou (or a fraction of a millimetre) below the neck. Cut and stick a thin layer of masking tape over the channel to prevent glue from running into the rod and locking it solid. Apply the glue to the neck – we used Titebond as it's an excellent fingerboard glue that dries reasonably quickly and clear. We haven't shaped or radiused the fingerboard or neck yet, so there's no need to be too precious with your clamping; just get as many on there to hold the whole thing flat while the glue sets. Place the board on the neck, locate the pin holes, tap the pins gently in with a hammer to locate it, and then clamp the whole thing down.

Once the glue has set we can trim down the fingerboard flush to the neck and then cut the headstock section down to 15mm. We used the bandsaw for this cut, but if you're using a handsaw leave some room for filing and sanding down to the correct depth. Mark out and cut the headstock shape. I've used an approximation of the original shape, but you could use whatever works best for you.

Now is a good time to radius the fingerboard. We're going for a bend-friendly 12" radius rather than the vintage Fender 7.25" on the original. A radius block is very useful here, and we certainly used one. Take your time and start with an aggressive 180-grade paper and work the radius in evenly up and down the entire length of the board, checking regularly with a radius gauge and straight edge, and finish with 320 paper.

Now we can roughly shape the neck and ensure that the taper and sides are straight. The original RS boasts a neck profile of truly mammoth proportions, and ours is similarly chunky with an inch-thick profile from first to last fret. We used files, rasps and finally sandpaper to carve the neck, and it didn't take very long, as it's so huge! If you decide to use a shallower profile then always be aware of the depth of the truss rod, as this alone dictates how much wood can be removed from the back section of your neck blank.

The Neck Pocket

Once happy with the neck profile, we line it up on the body. For an RS we want the neck/body join to be approximately at the 20th fret to bring the bridge position into the right place. Measure and redraw the centre lines on the body and line up the neck heel. Once satisfied that it's central and located correctly, draw around the heel. This outline gives us our neck pocket. We need to rout this out, so we use >

20 Now the neck tenon can be sanded flush

21 Drilling the tuner holes to 10mm

22 Colouring the neck with mahogany stain

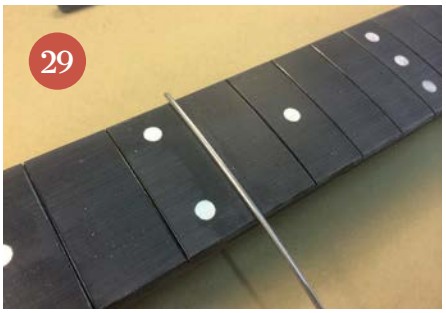
23 The fingerboard will be sprayed or dyed black

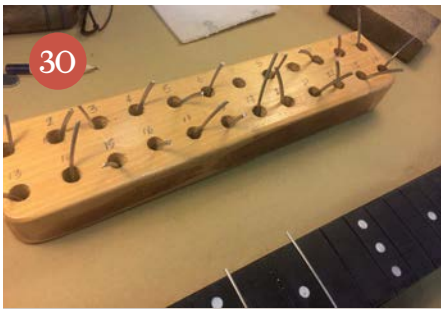
24 Routing out the large control cavity

25 Some work still to do, but we're ready for stain

26 Applying the Rustins Plastic Coating

27 Pin-striping the edges





28 Polishing the body

29 A light sanding levels the dots. Now for frets...

30 Pre-bent frets ready for installation

a quick template by lining up two straight-edged pieces of MDF offcut along the sides, and measure and cut a piece for the rear of the template. Double-sided tape is once again used to secure the template, and then we gradually rout down to 15mm depth. The neck drops in tightly so we can remove the temporary template. We leave enough height to set an angle in the neck later, but now we can glue the top section of plywood to complete the body. Once dry, we use a flush-cut router bit to reveal the neck pocket through the plywood top.

We now need to set the neck angle. Rather than cut it into the heel of the neck itself, we rout the neck pocket to an angle. There is no set angle here – it's determined entirely by the bridge that you choose to use. A Fender bridge requires very little angle; a wrapover requires a reasonably steep pitch. We're using a tune-o-matic, so we drop the neck onto the slot, place the bridge in its position and check the angle using a straight edge laid across the frets and onto the bridge to check the angle. We're looking for 'zero action', where the straight edge or strings can be lowered so they touch the frets all the way along; this will allow the guitar to be set up to any desired playing action. If you don't have access to a router, it's possible to drill and chisel this neck pocket – it will just take longer and more patience. We now rout the neck pocket at an angle using the same template as before with some simple wooden shims to lift one end and create a downward angle. Don't worry too much if the angle isn't exact first time – be patient, and slowly rout the correct depth. You'll have a small elevated piece of the heel showing at the end which can be either routed flush or removed with a plane and files.

Once happy with the neck angle we can trim the excess mahogany elevation that protrudes above the top. Once again use a router with a temporary template, or a small plane and files will do the job. Finish trimming the body edges so the sides are all straight, and correct or finish the cutaway blends into the heel/neck joint area.

Next we finish off shaping the headstock, drill the tuner holes to 10mm, and then rout the control cavity using the same flush-cut router bit we used for the neck pocket. We decided to use a control layout similar to the original, so we cut a fairly large opening in the top to allow for the pots, switches and pickup hook-up wires to be accessed easily. The pickguard is designed around your cavities so feel free to place the electronics wherever works best for you – you don't have to stick slavishly to the original design.

Finishing Tips

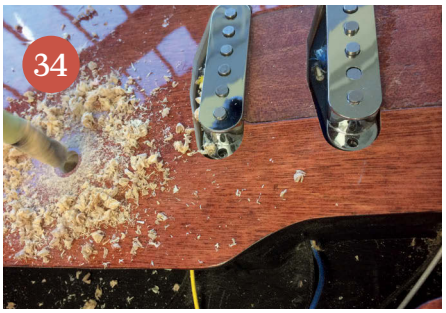
The original RS painted in many layers of Rustins Plastic Coating, a two-pack high-build lacquer traditionally applied with a brush. We decided to use the same product – it's a great way of achieving a high gloss result at home – but we plan to cheat a little by spraying it on. Once the neck and body were prepped using fine paper down to 500 grade to leave a little key for the lacquer, we stained the neck and body using mahogany wood stain. The famous red of the original is really more of a woody orange/brown in the flesh, and once lacquered this stain takes on just the right hue. Next we mask off and darken the oak fingerboard using nothing more than a black aerosol. The whole thing will be lacquered in plastic coating later so this initial black coat is kept thin. A decent black stain will work just as well.

I was lucky enough to hand the whole thing over to our wonderful paintshop man Paul 'Rossi' Ross for the finish work, and he mixed the Rustins and then applied a couple of coats to the body and neck. The product self-levels quite well and is left to dry overnight.

On the original RS the sides of the body are veneered and bound

31 The side dots are short offcuts of plastic rod

32 Completed fingerboard with its Rustins shine



front and back. We didn't have the time to do either here but we couldn't live with a visible MDF join, so we masked off the back and top and applied an aerosol-based red oxide primer. It's not a perfect match by any means but it's a neat, quick and cheap solution.

The guitar looked great at this stage but the fact that the budget, brief and schedule didn't allow for real binding was bugging me. Rossi suggested coach pin-striping. For those of you born after 1985, this is a thin self-adhesive striping that is easy to apply and comes in 3mm x 5m rolls of gloss white for a couple of quid. After a final coat of Rustins, it really looked the part. With the body finish work dry and finish, we flattened the finish to 2000 grade wet & dry and then buffed with budget friendly T-Cut and polish.

Fingerboard And Frets

Now we turn our attention to some of the trickier neck jobs. With the neck dry from its initial lacquer coats, we block sand the fingerboard flat using fine paper and then install pearloid dots. We follow the somewhat unusual RS dot layout of 6mm dots with simple 2mm side dots made from white rod. The dots are marked out and then drilled to a 2mm depth and installed with a drop of superglue. Use a brad point drill for an accurate, sharp-edged hole. If they go in accurately they'll just need a slight rub to level, but be careful not to break through the finish. Painted dots or even self adhesive stickers would also work at a push, too.

We then install the fretwire. You can use whatever size you prefer, but we kept it vintage. An accurate description of fretwork installation would take up an entire feature on its own and we've covered many of the basics in past issues, so we'll keep this part brief. Pre-bend the fretwire beyond the radius that you've set in the fingerboard, cut 24 pieces to size and then tap the wire into the precut slots – you may find it helpful to apply a small drop of superglue to each end of the tang as you install them. Tap each fret down level with the fingerboard so it follows the radius and is seated flush without any gaps beneath the bead. Take your time and seat the frets accurately, as well-seated frets transfer tone.

Once installed trim the ends with a flush cutter and file the ends flush with the fingerboard – careful work here will retain the finish on the fingerboard and neck. Level and dress the frets using whatever method you prefer. Once the frets are level and the ends are smooth, we recoat the whole thing in Rustins. Don't worry about getting finish on the frets as we use the Fender method of scraping the finish off the frets once dry and polishing the whole thing as one. The result is a slick, glossy feel, just like the original. If you choose to avoid a lot of this extra work then just use a rosewood or even ebony fingerboard which won't need stain or lacquer but will give a different feel and tone.

Fitting The Neck

Once you're happy with the finish, the neck can be fitted. Once again we deviated a little; the RS uses a large bolt fixing and two smaller screws to secure the neck to the body, but I decided to glue it in for a strong sturdy join. Titebond was the choice once again and just one clamp was needed as the neck pocket was the perfect size (if you find that the neck is a little loose then consider a gap-filling epoxy resin glue like Araldite). Apply the glue and then clamp the neck using some protection for the back of the body. Check the neck angle for the final time using the straight edge, and then walk away and do something else while it dries. I used the time to screen the control cavity using screening paint.

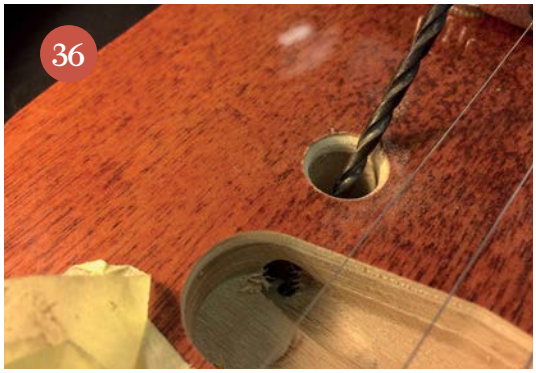
Hardware Time

Now it's time to fit the bridge and tailpiece and rout the body for the pickups. Apply some masking >

33 Gluing in the neck; we only needed one clamp

34 Drilling the bridge and tailpiece holes

35 Fitting the tuners. Running a ruler along the rear edges of the tuners will ensure straightness



36 Drilling for bridge posts and earth wire

37 Switchcraft jack socket from the outside...

38 Switchcraft jack socket from the inside

39 That massive and all-important scratchplate

tape in the bridge area and use your steel rule to draw two pencil lines along the neck onto the tape. Measure the gap between the lines and divide the measurement by two and mark it on the tape. This is your centre line for the pickups and bridge. A couple of notable compromises here: there are various versions of Burns Tri-Sonics available of varying quality and accuracy to Brian's originals, but they are all out of our budget. Bespoke units wouldn't have been in the spirit of this piece, so I settled on a used set of Wilkinson single-coils that I had knocking about. These are available on eBay for a tenner, so that sounded about right for our budget. Purely for aesthetic purposes I added a set of chrome plastic covers and splashed out on a set of matching knobs.

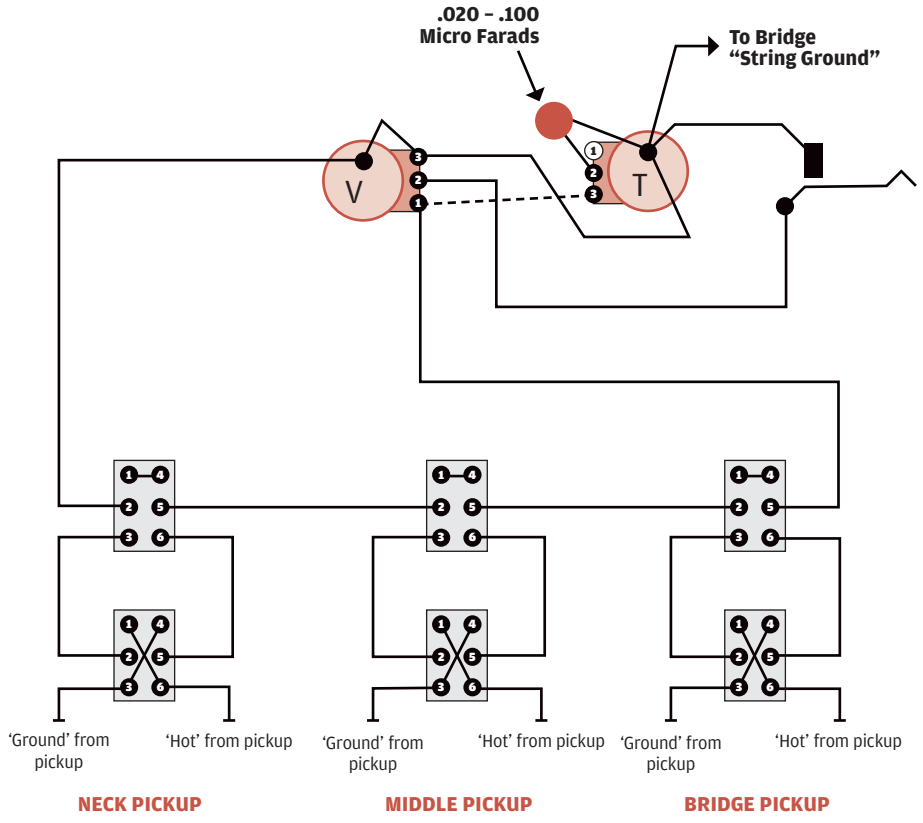
Mark out and place the bridge in position on the masking tape – the position of the top E string saddle is 24" from the centre of the zero fret, plus a couple of millimetres, and the tailpiece 50mm further back. Measure it all out and then space out the pickups and mark out where they sit using an empty cover. You have a choice to use a rectangular 'swimming pool' rout as found on modern Fenders or invest in or make a single-coil router template. Secure the template one pickup rout at a time, and rout to whichever depth is suitable – your steel ruler helps here to set the heights. If in doubt rout a little lower than necessary as the pickups can be shimmed upward easily enough but dismantling the whole thing to re-rout lower is a total pain.

Once the routs are complete we then drill for the tailpiece posts, install the inserts and then the tailpiece. We drill into the secondary piece of maple which was cut wide enough for the post width specifically for this purpose, and which lies 50mm behind the bridge posts. With the tailpiece fitted, place the bridge into the approximate position and then fit a set of strings. Before we do so we fit the tuners and string guide blank as we'll need to string her up soon.

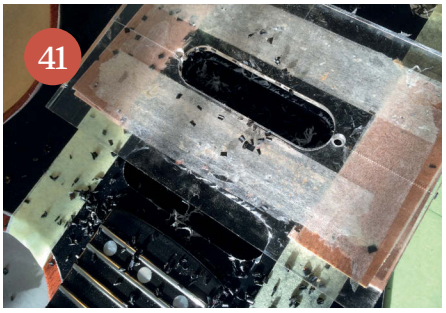
Without the posts installed you may need to shim the bridge to set the bridge position perfectly and mark out the bridge post positions. Remember, we're looking for the exact scale length plus a couple of millimetres on the treble side with the bass side a further couple of millimetres back. Slacken the strings, remove the bridge and drill the holes for the inserts as you did for the tailpiece.

We also have to drill for an earth wire from either the bridge or tailpiece – I chose the bridge for this build as once the bridge post insert holes are drilled it's easy to drill through into the bridge pickup cavity for the wire, as pictured. Run an earth wire from the hole through the pickup rout and into the control cavity and then hammer home the inserts snugly and then fit the bridge. Tune up to pitch and check that all is well – you should be able to achieve zero action with the bridge lowered to the body as low as possible.

PICKUP WIRING DIAGRAM



Credit: Esteban Anderson/AnderMay Guitar. Used with permission. All rights reserved



Making The Scratchplate

After installing a Switchcraft barrel jack – quick work with an 11mm drill bit through the side and a spanner to fit – we're on the home straight, but one tricky job awaits: making the scratchplate. There's no real quick, simple way to make a bespoke guard. In the real world we would make a template so the guard could be repeated or laser cut, but here we're making a true one-off. First, measure and cut a piece of one-ply gloss black scratchplate material big enough to cover the shape that we need. On the RS the plate stretches from the upper horn all the way down to and across the lower bout. We needed a piece 300mm x 450mm which ate up £20 of our budget but was well worth it to achieve the correct look. It's a good idea to practice the shape on paper or thin card which can be easily modified; when you're happy, this can be easily transferred onto the plastic material. Start by carefully measuring and then roughing out the shape and removing the lower left-hand portion so we can see what we're doing. Once the dimensions are correct we start by cutting out the fingerboard slot/surround, as this dictates the fit of the rest of the plate. When the neck cutout is done, the rest of the outline is fairly easy. With the outline in place, drill for the bridge posts and rout the pickups slots. A pickup template here makes sense but you could use an old butchered Stratocaster plate as a guide and drill and file the pickup holes to size. Place your volume and tone knobs on the plate and draw around them; centre and drill out the pot mounting holes in the plate to fit the pot shafts. We're using CTS pots so we drill out to 10mm. Install the pots and pickups and it begins to look like a guitar!

Electronics

The original intention was to use a 3- or 5-way selector switch wired up to give the most used of Brian's sounds; in fact I did hook up a 3-way with the bridge and middle permanently in series, and it sounded so good that I decided to blow the budget and invest an extra few quid in a set of six slider switches to allow me to wire her up like the original with on/off and phase reversal switches for each pickup. One of the master strokes of the original design was to wire the pickups together in series rather than the more usual parallel, and the many combinations that this offers are really only available by using the original wiring scheme. Not only would the switches complete the look but more importantly they would open up the full range of sounds available. Sadly I had left the decision until the last moment so I couldn't source white switches – black ones would do for now as I could always swap them later.

Fitting the switches is a little tricky. I mounted them directly to the plate rather than on a separate metal plate beneath the pickguard as on the original. Firstly we measure and mark out the switch slots in the plate and then, using a 1mm drill bit, drill out the corner points of each rectangular slot. I then used a Dremel with a small router bit to rough out the slots before squaring them up with files. Drill the mounting holes and install the switches, wire it up and we're done.

There are many conflicting wiring diagrams around, but ours is shown on the last page. In essence each pickup is routed first through a phase reversal switch and then through an on/off switch which joins the pickups together in series... so, for example, bridge pickup plus middle pickup together in series creates a pseudo-humbucker – the sound Brian May uses for most of his heavier midrange tones.

Once wired up and after a set-up to set intonation, we finally plug her in and enjoy the sound and feel. The neck is massive... possibly a little too big, which certainly explains why the majority of the commercial copies use a smaller more sensible neck profile, but the tone and warmth is undeniable. Of course it won't make you sound exactly like Brian May – even his own guitar won't do that for us mere mortals – but for a few quid and some time spent with tools it will get you a good deal of the way and is sure to be truly great fun.

Dave Walsh is the head honcho of Eternal Guitars and Hot Rod Pickups. For more info: www.eternal-guitars.com or www.facebook.com/hotrodguitarparts

40 The drilled out pot mounting holes

41 Routing for the pickups

42 Cutting holes for the slider switches

43 On/off and phase reverse for each pickup

44 Our micro-budget RS, finished and ready to rock

THE BUDGET

We went slightly over our £150 target on this project but most of the extra dosh went on good quality electronic components and decent wood where it was needed...

- **Neck and fingerboard £35**
- **Body materials £10**
- **Paint £15**
- **Hardware: £35**
- **Electronics £36**
- **Pickups: £10**
- **Plastics £25**
- **Dots £5**
- **Total materials and build cost: £171**

REPAIR WORKSHOP

DAMAGE CONTROL

Sometimes an expensive fix just doesn't add up. Luthier **DAVE WALSH** helps assess whether your guitar is worth mending

Are guitars disposable objects? Luthiers don't think so; after all, they make their living maintaining them and increasing their lifespan. Every so often, though, they run into a repair that isn't viable. Sometimes it's a case of sentimental value, as when a customer strolls in with a mangled guitar that their late great aunt left them. The trouble is, even if mint, it's only worth a couple of hundred quid – but a full rebuild will cost double that. At other times, a customer may request a repair on a budget instrument that just isn't worth the work. You'll be amazed at what can be fixed, but in the current climate of very low-cost far eastern manufacture and well-made budget models, the lines can get blurred.

So when is it time to assign your axe to the skip? Here's a rundown of some common and some not so common repairs/issues that may seem deceptively simple to repair.

Broken Headstocks

Broken headstocks 1 are an extremely common ailment, particularly on mahogany-necked instruments, and thankfully in most cases – well, on a decently-made guitar – they can be relatively straightforward to repair within a reasonable budget. However, this is not a repair for the novice, even if it seems tempting to apply superglue, Araldite, Prit Stick or wood screws (I've seen them all). Specialist clamps and cauls plus a lot of experience is needed to assess the correct method and approach for returning the headstock to a one-piece item.

A shallow-angle split with the headstock still attached and plenty of gluing area is a fairly inexpensive fix on a mahogany-necked guitar (minus any refinishing work to conceal the repair), but on maple – or with a full break-off at an acute angle – then more elaborate surgery including wooden splints to reinforce the join may push the repair beyond a sensible budget on cheaper guitars.

Snapped truss rod

A broken truss rod 2 – less common, and often a result of heavy-handed 'maintenance' – can be one of the trickier jobs to rectify. In many cases the fingerboard will need to be removed to allow a new rod to be inserted. On a Fender-type electric, the skunk stripe will need to be routed out and replaced after installing a new rod. It's worthwhile on an old, valuable guitar or a higher-priced model, but if we're dealing with a cheap acoustic then, realistically, it may be time to assign it to the bin. On a cheaper bolt-on electric, a new neck may be more cost-effective than repair.

Detached bridge/belly top

It may look terrible – particularly if you're tuning or playing the guitar at the time – but a detached bridge 3 is a common occurrence. There are often unseen reasons for the bridge to lift away from the soundboard. On older guitars the hide glue may have reached the end of its adhesive lifespan, drying and becoming brittle to the point where it can't handle the string pressure; in this instance the bridge can be re-seated, and all will be well. However, if the top has begun to 'belly' upwards because the internal struts and bracing beneath are loose or broken, then more extensive surgery will be required. On a cheaper acoustic a bridge may come away that was not glued down well in the first place; some modern manufacturing dictates that bridges are glued onto the lacquered guitar top, so the bond is only as strong as the lacquer adhesion. On older or more expensive guitars the lacquer is carefully removed so the bridge is glued firmly to wood, and any repair should include this simple procedure. A good luthier will also check that the bridgeplate which the string ball ends anchor against is sound and strong enough to effectively spread the string pull across the bracing. On very cheap guitars the bridge can be re-attached with countersunk bolts.

Separated neck

It's unusual to see a set-neck guitar come away cleanly in two parts 4 these days, as modern glues tend to keep the heel joint

1 The dreaded neck break: the value of the guitar and the neck material are both important factors

2 Over-tightening a truss rod can have expensive results

3 See a tell-tale crack at the rear of the bridge? Detune the guitar and seek help

4 Cleaning up a fingerboard tongue after neck removal: necks set like this need really expert attention

somewhere between pretty snug and indestructible. However, if it happens, it can usually be repaired – unless either part is smashed into smithereens. Old hollowbodied Hofners are particularly susceptible to this sort of break, as are certain vintage Gibson SGs where the neck tenon joint has been routed away for the neck pickup. On older acoustic guitars, the neck often pulls into the neck block and raises the action; this means a neck re-set, where the old glue is softened (usually using steam), removed, and then re-set at the correct angle. As all of the above is specialised work, it's only viable on guitars above a certain price bracket. If you have a cheap acoustic with a high action caused by a badly angled neck but otherwise in good shape, then consider keeping it for slide

Smashed acoustic

5 Acoustic guitars are under a lot of pressure. If you think of the body as a lightweight speaker box, then add the pressure of the neck being pulled inward by string pressure while the strings simultaneously try their best to pull the bridge away from the top of the guitar, then you've got a volatile mixture. An innocuous knock can open a small crack in the body which can soon open up into a major structural problem unless patched and strengthened. Now, anything can be repaired, but if the back, top or sides on a relatively inexpensive acoustic are split – particularly across the grain – and the bracing is smashed, then it's full-rebuild time. Also, as most acoustics also have a translucent finish, any repairs will always be visible without a refinish of some sort. Solidbody electrics are still 'acoustic' in nature and suffer some of the same string pressures, but they're far hardier so even a body completely split into two pieces can be glued back together. However, refinishing will be needed to hide any serious repair, and this puts the repair costs into the unviable bracket on budget guitars.

Refinishing

6 Refinishing a guitar – either electric or especially acoustic – is a far from simple task. When you wander into your local repairer shop with a black-finish Strat copy and ask for it to be painted red, don't be surprised if he tells you to sell it and buy another one in your chosen colour.

Higher value guitars or badly refinished vintage pieces are a different kettle of fish. They've already been devalued, so a really good sympathetic refin can restore some collectability. Acoustic guitars require a lot of work to refinish, including removal of the bridge, and unless you're going for an outlandish 'video prop' design you'll rarely be greeted with a positive reaction, as changing the finish will also to some degree change the tonal output (the same is true on an electric guitar, but it'll be particularly noticeable on an acoustic). Be prepared to pay high prices if you insist on this type of work – usually more than it's worth if it's a mid-budget sub-£500 guitar.

Another refinishing conundrum is the scratch/ding situation. I've often had players come to me devastated because their brand new guitar has a scratch or chip. At this stage their pride and joy needs to be restored to its original pristine condition or the world will stop turning on its axis. Of course, it's possible; many scratches can be polished out, but if the finish has been scratched down to the wood then in truth the only way to completely hide any finish damage is a total refinish. Even if refinished it could soon pick up another knock along the way, and it's best to try and live with the imperfections.

The vast majority see sense at this point, but not all. I've seen a chap pay hundreds of pounds for his electric to be refinished to hide some relatively minor damage, only for him to arrive to collect it from the workshop, take it from the case in an over-excited manner and turn around to show his mates... and whack it hard against a door frame. You live and learn!

5 The nightmare scenario. Even cracks like this can be repaired, but the job won't come cheap

6 Full refins like this can cost many hundreds of pounds. Maybe it's best to live with the battle-scars

DIY WORKSHOP

ELECTRIC LEARNING LAND

Your guitar doesn't work. But what's wrong – the jack, the pots, the switch or something else? Before you visit the professionals, read our basic guide to troubleshooting electric guitar wiring

The most important aspect of successful electrical repair work is an efficient diagnostic approach that enables you to find out exactly why a circuit is malfunctioning. Diagnosing electrical problems is a tricky process combining a little hardcore knowledge with intuitive judgement and a disciplined process of elimination; of course, accumulating knowledge sharpens up your intuitive judgement and reduces the time spent eliminating possible problem areas.

Before attempting guitar electro-surgery, however, it's necessary to understand a few basic principles. The most important principle is that electricity – or, more to the point, electrons – flow in circles; if a circle is broken, the electrons can't flow and the circuit won't work.

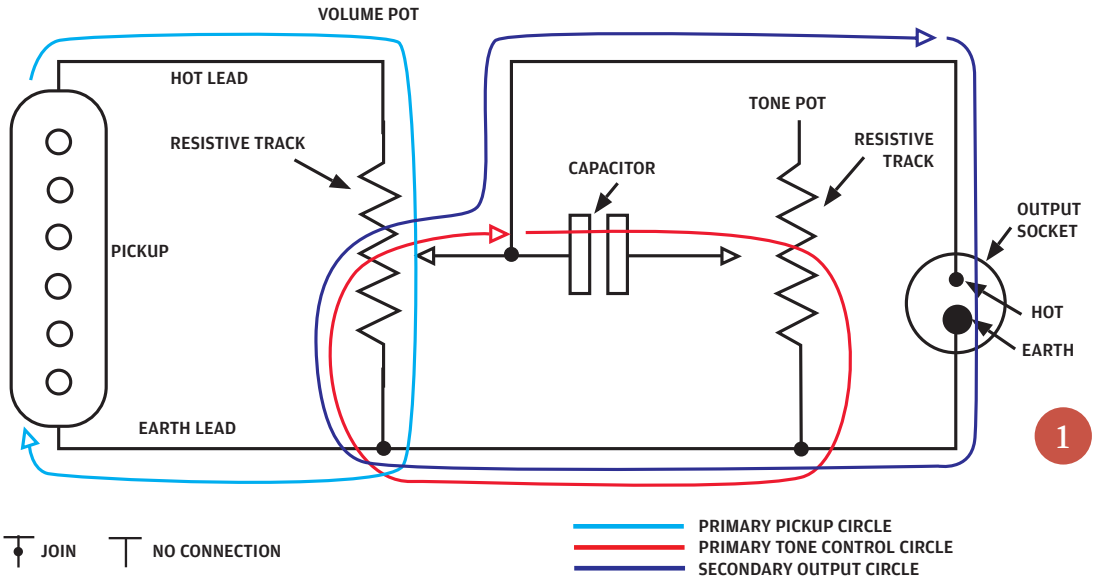
The wiring system within a guitar is made up of many circles, most of which are straightforward and easy enough to spot and check. Troubleshooting electrical problems always begins with 'check the circles' testing because just one broken circle somewhere in the circuit can silence the entire system; find it, repair it and the job's pretty much done.

Spot the circle

Let's consider a single-coil Strat-type pickup connected to a volume control, a tone control and then an output socket (see Fig 1 on the opposite page). The pickup circle starts at the top of the pickup coil at the 'live' or 'hot' lead or wire, which then connects to the top tag of the volume pot; this lead carries the all-important output from the pickup. The bottom tag of the volume control is then connected to the bottom connection of the pickup coil to complete the circle; this lead is called the earth or, to use its full name, the earth return. In action, the electrons flow out from the pickup's live lead, down through the volume pot's resistive track and back to the pickup again via the earth return. In the diagram you can see that the bottom of both the pickup coil and the volume pot are also connected to the body or casing of the volume pot, which becomes the main earth connection for the circuit.

This is an example of a primary circle. It's primary because the resistive track in the volume pot is wired across the pickup at all times. Fig 1 also shows another primary circle, the one used around the tone control; again, notice that the circle is never broken.

Another type of circle, a secondary circle, is used to pick the output off the middle or 'wiper' tag of the volume control and send both it and the earth connection via the guitar lead to the amplifier, where the circle is completed. Secondary circles are interesting because they are not true circles until something makes them so – the position of a



1 This diagram illustrates the primary and secondary circles connecting a single coil pickup to its volume and tone pots

switch, for example, or ultimately the guitar amplifier itself.

Conductivity

Primary and secondary circles may be different, yet both rely on a good earth return in order to work. It's because of this that they are prone to breakdown, and for the same reason – poor conductivity.

In primary circles, high resistance solder connections (aka 'dry joints') introduce this poor conductivity into a circuit, and nine times out 10 they can be cured by a simple jab from a hot soldering iron. Resoldering a dodgy dry solder joint restores its electrical resistance to the electron flow to nearly zero ohms and, more importantly, fixes it at that point; the joint then presents the same near zero resistance each time it is used, and so becomes reliable.

Secondary circles can also suffer from dry joint syndrome, but they're more likely to be troubled by 'dry contact' syndrome – a condition where the contacts within a switch, a pot or an output socket become tarnished. At its worst the tarnish is actually a thin film of very high resistance oxidation which prevents the electrons getting through. It's possible to clean contacts to remove the oxidation, but as oxidation eats into the surface of the contacts and takes away any hope of true reliability, the best cure is often to bin the offending part and go for replacement. At best, however, the electrons are halted by a thin film of crud shed by you, the player. This can usually be removed with appropriate spray cleaners, but be warned: crud is an acidic sweat-based compound, very partial to electrical contacts!

Spot the difference

Components suffering from heavy crud build-up will work properly most of the time, but every now and then they'll need to be hit extra hard or given a vicious waggle to make them operate; conversely, components suffering from oxidation become very sensitive and usually only work if they are left untouched by the player. Both problems are very common and relatively easy to spot.

Hunting the fault

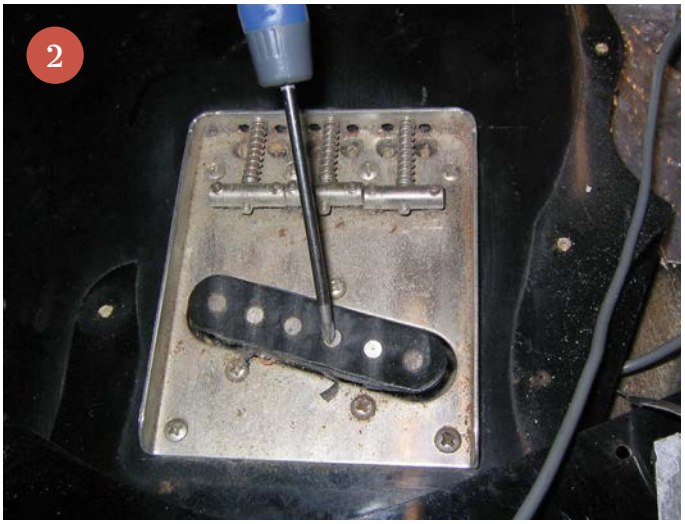
Freshly armed with your understanding of circles and dodgy joints you are now ready to troubleshoot just about any guitar. First, plug the offending instrument, with its volume and tone controls turned up full, into an amplifier. Select the neck pickup position on the selector switch, and hit the strings. If you hear nothing from the amp, flip the switch to the bridge pickup and hit the strings again. If you still hear nothing, jiggle the lead in the output socket and listen for a crackling 'make-or-break' noise from the amp. If you hear a sudden rush of sound, then you've found your major problem – the jack socket contacts and/or its solder connections are breaking the output's secondary circle. Equally, you may find that the output socket works fine and jiggling the pickup selector switch restores the sound. Whichever way, the nature of the problem is the same: poor solder connections on the component and/or tarnished contacts within it are interrupting or breaking the circuit circle.

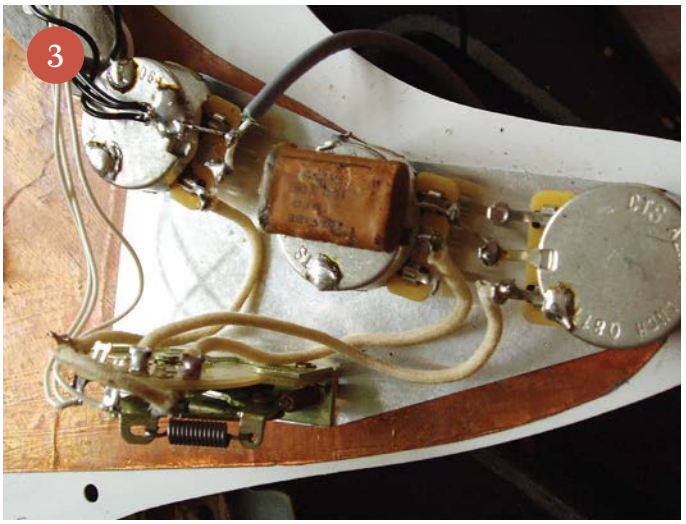
Volume and tone controls can also silence an otherwise functioning primary circuit circle if a resistive track on a pot has become so filthy that the wiper is unable to pick up the signal. Spotting this problem is simplicity itself: if the amp is filled with gritty sandpaper-type noises as you turn the pot back and forth,that's the tell-tale sign that the track and wiper are dirty and need to be cleaned or the part replaced.

The diagnostic nature of electrical repairs has a real Sherlock Holmes feel and it can be very satisfying when the problem is discovered.

External examination

Next, armed with a pencil, let's troubleshoot a Strat with a noisy pickup selector switch. Start with the same test procedure as outlined before: plug the instrument into an amp via a lead and turn all the guitar controls up full. Waggle the switch back and forth and listen to the noises from the amplifier. A switch that is working properly will create a mild 'click' from the speaker as it moves between the settings (this level of switch noise is acceptable, as the switch is making and breaking the signal path). A switch with worn or dirty contacts will sound and feel altogether different – moving it between the settings makes the amp crackle and roar, and the switch may feel >





2 Clunk-testing pickups works on any guitar with exposed polepieces, such as this Telecaster

3 The standard Stratocaster style wiring

stiff and difficult to move.

We already knew the Strat had a dodgy switch, so before removing the scratchplate to fix it, check if there is anything else wrong with the guitar. Start with the pickups, and be sure to note the results of your tests on paper as you go along.

Testing the pickups

Select the neck pickup and turn the amp up a little. Next, hold a small steel screwdriver by its blade and touch it onto each pole of that pickup **2** (you may want to lay the guitar down flat). The screwdriver will be drawn by the magnetism and should make a solid 'clunk' sound from the speaker as it makes contact with the pole. If that is all you hear, then the pole has passed the test.

Before moving on to clunk-test the next pole, make sure that the screwdriver is NOT being earthed out by touching a string. With the screwdriver correctly in place on the pole touch the blade and listen out for a loud hum from the amp. If the speaker still remains silent then the pole is functioning correctly, if it hums crazily then you have discovered a fault which could be within the pickup, its wiring connections or both, and this fault could also be contributing to the noisy switch. Move the selector switch to the middle pickup and test its poles in the same way, and finish up by clunk-testing the bridge pickup.

Next, hit the strings and turn the volume pot down and up to see that it works properly without adding any crackles to the sound. Copy the test with the two tone controls (just remember to select the correct pickups before you check the pots). When checking tone controls, also listen out for how the tone changes as you turn the pot up and down. If it behaves more like a volume control than a tone control then there is fault either with the pot, its capacitor, the wiring around the component, or all three.

The verdict

We've carried out our external examination of the troublesome Strat. What do we know? Well, the selector switch has had it, the pickups seem okay, but the first tone control (the one for the neck pickup) is noisy and doesn't sound quite right. Of course, you would have jotted all this down on your checklist. So now it's either time for some DIY or if you don't feel happy about that, a trip to a repair person.

Under the hood

If you're going DIY, the first step is to access the offending controls. Slacken and remove the strings and with a small cross-head screwdriver remove the scratchplate screws; place them on a tin lid or similar for safe keeping. Pull the scratchplate upwards and out from the body and turn it over to see underneath. Watch out for the output socket leads and the bridge earth wire, which will still be attached to the guitar body.

The photo above on the left **3** shows a typical Strat scratchplate; you can see how the three pickup 'live' leads go straight to their respective terminals on the switch, whereas the three pickup earth leads, and the bridge earth lead, are soldered together onto the back of the volume pot. This all-together-in-one-place earthing technique is a very reliable way to make a main earth return point for both the audio signal and the earth plane screening within the guitar. Some Strats also hardwire the casing of both tone pots and the chassis of the five-way switch to the casing of the volume pot, a technique which ensures that all the exposed metal parts of these components are properly earthed.

Unfortunately, older Strats and many copies omit these additional earth wires and instead provide the metal parts with an earth connection via a metal foil screen stuck to the rear of the scratchplate. The electrical connection is made by squashing the foil onto the underside of the pot when the fixing nut is tightened. The squashed foil approach is fine when the guitar is new and clean but oxidation and dirt can build up between the foil and the pots which increases the electrical resistance of their connection and upsets the earth return for the tone controls.

Back to our theoretical patient. The switch? It's possible that cleaning might quieten it, but the best solution is to bin it and replace it with a new one. Dirt and crud has also built up between the foil and the first tone control, which is cleanable and so repairable. If this were a real guitar I would hard-wire the tone controls and the switch to the casing of the volume pot and thereby avoid this particular problem happening again..

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DIY ELECTRONICS 1

TOOLS OF THE TRADE

Don't know your cross-head from your multi-core? Scan your beadies over these pages for a comprehensive outline of the basic tools required to work on electric guitars and basses

You don't need a workshop bulging with gear to repair electric guitars – all it takes to get started is a handful of tools costing as little as about £35, and a clear table top (plus, of course, access to a mains socket to power a desk light and a soldering iron). Fortunately, most of the tools used to repair electric guitars are the same as those you would use for regular domestic electrical work. Here's a typical list of tools required for electro-surgery

Screwdrivers

Medium-size Philips cross-head – for scratchplate and cavity plate screws, switch screws and pickup screws, and so on.

Medium-size flat-blade – for most control knob fixing screws, plus Gibson humbucker-type height adjuster screws.

Pliers

Small to medium sized wire cutters (also called electrician's cutters).

Medium-sharp knife

A small kitchen knife with a three-inch blade – the size you might choose to cut small vegetables – is my favourite. The blade isn't as sharp as a scalpel, but this reduces the chances of cutting both the insulation and the multi-core wire when you strip the end of a wire in preparation for tinning. This can be tricky on both screened and unscreened wire.

Small table-mounted vice

A 3" to 4" bench-mount type is best. Maplin and B&Q have many suitable small vices on offer; some are fixed to the table by a single screw clamp, while some are held by a devilishly cunning sucker mechanism. A great first-time vice is available from Maplin; they call it a Hobby Vice and it costs around £15. The vice is vacuum-mounted, and is man enough for most jobs. Their Table Vice, however, is a much better bet, and it costs about the same. This vice mechanism is well-made with a very cunning 'fit any situation' table-mounting system – great for guitar techs.

Desk light

Any domestic Anglepoise-type light will do.

Box spanners

You will need a set of three double-ended box spanners which have different-sized spanners at each end: 12 and 13mm, 10 and 11mm, and a 2 and 4BA. Box spanners are a really useful tools as they allow you to slacken and tighten nuts on a guitar without endangering the finish or the scratchplate. The three sizes quoted cover the volume and tone control nuts, the larger output socket, and the mighty fiddly miniature toggle-switch fixing nut. The output socket nut on guitars that use a recessed output socket, such as a Strat or Telecaster, can only be tightened well with a box spanner, so this size is a must.

Soldering iron

You will need two soldering irons, a 15W to 25W pencil-type, and a whopping great 100W soldering gun. The pencil iron is used mostly for soldering the wires that carry the signal of the pickups; these connections are quite small and so relatively easy to solder quickly and successfully. My favourite iron is an Antex 15W pencil type which is light and heats up rapidly. It'll cost around £20 from Maplin.

The solder gun is used to unsolder earth connections to the metal casing of volume and tone controls. These are much harder to work on than signal connections because the metal casings are substantial enough to draw the heat away from a small iron and so prevent the solder from melting.

This 'earth the casing' technique is important because it provides both a reliable and an effective method of distributing the earth

2

1 Left to right: a Philips screwdriver, box spanners and a table mounted vice

2 Left to right: a soldering gun, a pencil soldering iron and a pair of pliers

return within the guitar and also valuable EMR hum and buzz screening. Sadly, the connections to the casing are impossible to unsolder with a low-wattage soldering iron; this is a job best left to a solder gun which heats up rapidly when you pull and hold the trigger. Do that and it's ready to pour serious wattage into the solder connection – then the gun happily turns itself off and the tip cools down when the trigger is released. My own gun is produced by Weller and has proven itself to be a reliable and effective bit of kit. Most regular DIY stores will sell this gun or one very like it from around £30.

For the one-stop shopper some online outfits offer complete soldering kits for around £30, which can come complete with a 100W gun, a 30W pencil iron, a miniature workpiece holder and a bundle of spare bits and solder.

Multi-core solder

Medium weight 'multi-core' solder is suitable for both signal and earth connections. Buy small amounts to begin with, and rolls when you've got the hang of it. Down the centre of this solder run four or more lines of flux which travel the length of the solder, in Brighton rock lettering style. The flux is a nasty concoction of chemicals which eat into the surface of the metals to be soldered – an important brew, as it cleans the metal surfaces and aids the transfer of heat from the gun, but it stinks when it melts so try not to have your head over the iron looking down when the little puff of smoke comes up! This position guarantees a lung full of unpleasantness which is probably very unhealthy.

Soldering: the rules

Electrical soldering is an easy skill to master if you follow the right procedures. It's all about preparation, an organised worksurface, and good technique. In fact, if you need the four golden rules of soldering, here they are...

1) All contacts to be soldered together must be clean of tarnish and oxidation, made tidy and correctly 'tinned'.

2) Contacts to be soldered together must be placed together and heated up by the iron sufficiently to melt the solder tinning before any further solder is applied to them.

3) The new joint must remain totally still whilst the solder cools.

4) Only use multi-core solder.

The first three rules require a little practise to perfect.

Cleaning duties

Cleaning the contacts before soldering is important because it ensures that the solder takes quickly to the new joint. Speed is of the essence here as it saves the rest of the component from excessive heat stress, an important consideration on small components such as capacitors, switch contacts and the insulation on most of the signal carrying wires.

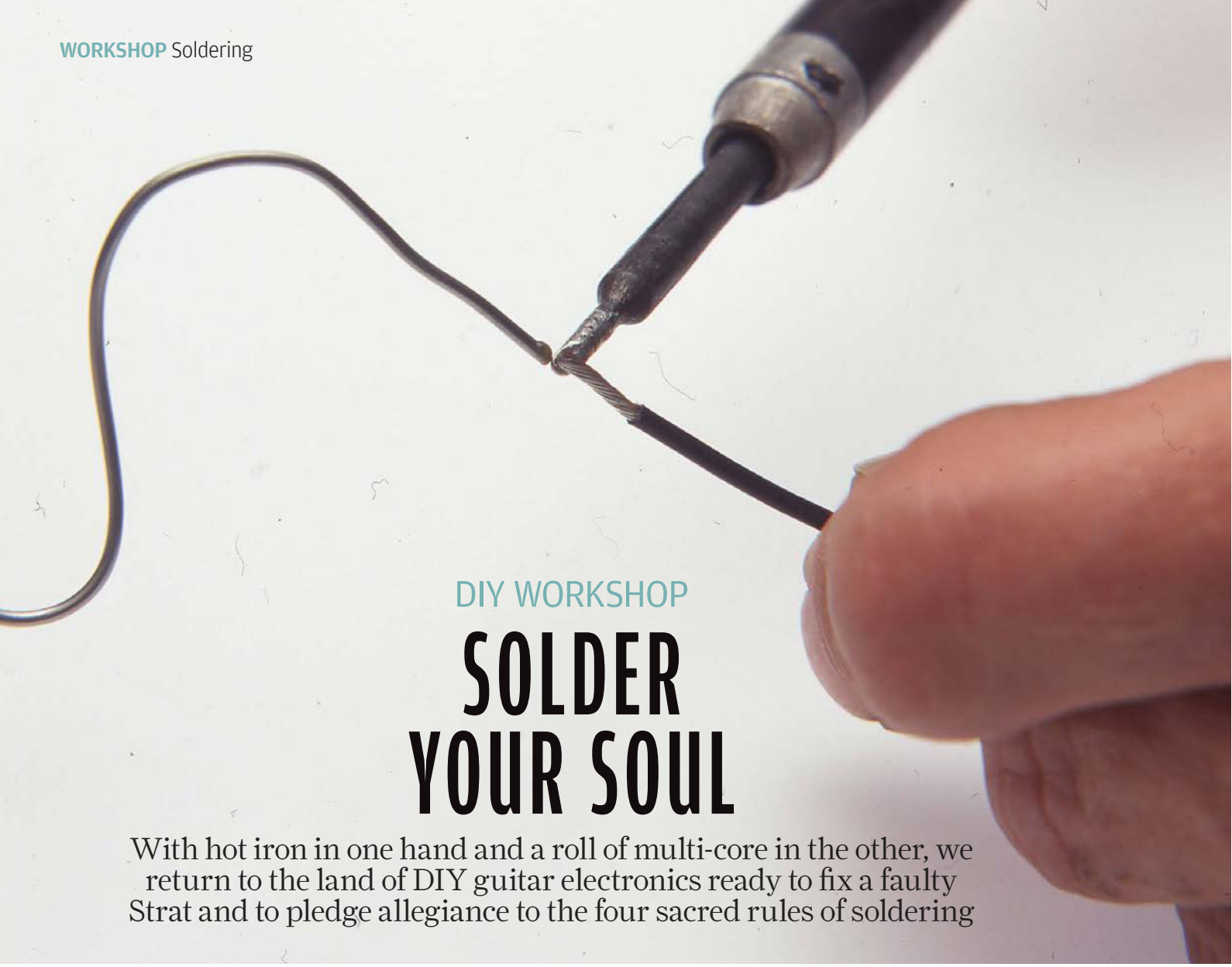
Once clean, the contacts are tinned with the iron, leaving a thin layer of solder on the end of the wire or on the surface of a contact or solder tag. This prepares them to be soldered back into the circuit.

Tinning a wire

You'll encounter three sorts of wire in electric guitars: single-core, multi-strand and screened. Tinning a single-core wire is the easiest: first, strip off a short length of insulation to expose the wire inside, and scrape it with the knife. Next, apply the tip of the hot iron to the wire and wait a second or two for it to warm up. Now push one end of the solder onto the wire and watch as it melts instantly on contact. Pull the solder away from the wire and then remove the iron. The wire is properly tinned when the entire surface of the exposed end is plated with a thin coating of solder.

The most common type of wire you will encounter is multi-strand, which contains not just one core of wire as in the previous example, but many. These strands must be twisted together tidily before the wire is tinned; the twist and the solder tinning ties the strands together so that they will not unravel when joined into the circuit. Apply the iron and then the solder as before.

Although tinning is the simplest part of soldering many people skip it, hoping that sheer willpower will make it happen correctly. Don't be tempted – a little cleaning and tinning can save hours of work and some deep-fried components.



DIY WORKSHOP

SOLDER YOUR SOUL

With hot iron in one hand and a roll of multi-core in the other, we return to the land of DIY guitar electronics ready to fix a faulty Strat and to pledge allegiance to the four sacred rules of soldering

In the last workshop we outlined the basic tools you will require for guitar electronics work and went on to introduce multi-core solder and the four sacred rules of soldering. Rule one, 'thou shalt always tin', was explained, and we examined examples of thoroughly tinning both single and multi-core wire. We also explained the fourth rule concerning multi-core solder.

Now it's time to fully investigate how to deal with rules two and three. However, for the sake of completeness, let's review the four rules in all their glory.

1. All contacts must be clean of tarnish and oxidation, tidy and correctly tinned.

2. Tinned contacts must be placed together and heated up by the iron sufficiently to melt the solder tinning before any further solder is applied.

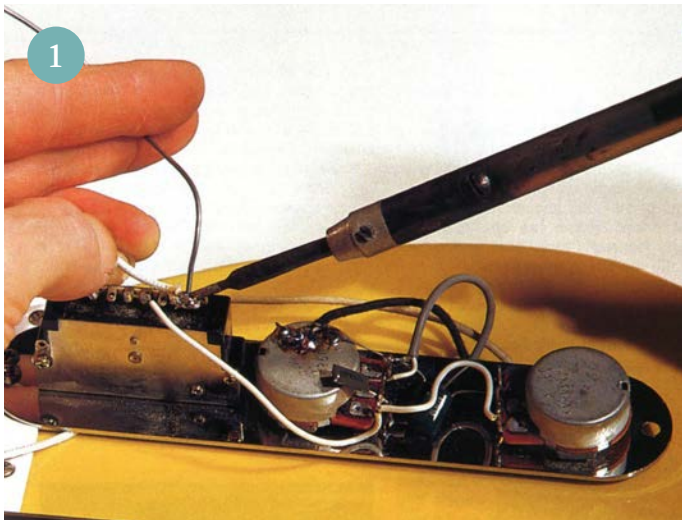
3. The new joint must remain completely still whilst the solder both melts and cools.

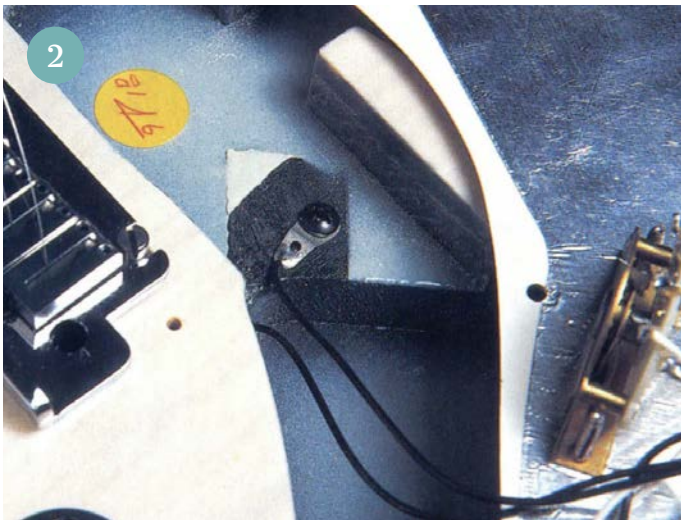
4. Only use multi-core solder.

As you may have guessed, rules two and three happen in quick succession, and once you have them mastered they'll appear like a single action. If they don't run together smoothly then you'll undoubtedly create a high resistance dry joint... not good, and not clever. Making it all happen correctly as one action is difficult because soldering usually requires three hands: one to hold the loose wire in the correct position, another to drive the soldering iron, and a third to guide the solder into just the right position at just the right time. Making do with two is not really a hardship, but it does mean that you will have to learn a few tricks to create a third hand – and maybe even a fourth – wherever and however they are needed.

A great deal of imagination can go into devising extra hands out of objects that are readily available, an approach I take myself as no two joints are ever quite the same. It's possible to buy soldering aids from electronic companies like Maplins; these cunning devices use flexi-mount crocodile clips to hold wires and components where you want them while you apply the soldering iron. These can help you set up the job so that the eventual soldering can be unhurried and therefore efficiently brief.

One good way that the first extra hand is used is to hold the source of the solder in a fixed position so that a length of solder can be unwound and arranged just as you want it. A large reel of solder helps out here since it's quite weighty and stays where you put it on the table. The stability of the reel, then, is your first extra hand; solder from a light plastic dispenser is harder to manage though it can be held





firmly by a laying it on its side beneath a book or heavy ornament.

Once the source has been tied down, sufficient solder can be unwound and arranged to be in close proximity to the work area. Arrange the solder so that it leaves the reel as close to your work top as possible and bend it upwards at 45 degrees as you approach the work. An unsupported length of solder will try to droop or move away from the job at just the wrong moment, so next introduce an S-shaped bend two or three inches from the working end of the solder to make the it more rigid and manageable. The S shape is another extra hand – if you arrange the solder like a crane over the new joint it should stay still and ready to use

With the solder crane in place, the iron hot and the Anglepoise on, let's consider a fictitious solder job: you have just fitted a new neck pickup to your beloved Telecaster and are about to solder the live output lead to the switch and the earth lead to the rear of the volume pot. The control plate is open and the plate mounted switch lies tags-up, ready to go under the iron. Having tinned the tag and the pickup hot lead, touch the tip of the iron back onto the tag. Watch carefully as the solder melts on the tag as the heat is transferred across from the iron. When all the solder has melted, push the tinned tip of the pickup lead through the hole in the tag and watch as the heat from the tag is transferred across to the wire. Remove the iron only when the solder tinning melts on the wire, and as you do so, blow on the joint to cool it down. The hand used to hold the wire must remain completely still so that the wire does not move as the solder cools.

At this point the wire is soldered to the tag, but the joint is not very strong; more solder is required to make it reliable. Adding extra solder can be quite tricky as the joint will probably spring apart if you apply the iron a second time. This situation calls for dexterity, more cunning and a little rule-bending. I use a technique that involves using my left hand to hold the wire in the correct position with my thumb and little finger while I guide the solder from the aforementioned 'crane' between the remaining three fingers onto the joint. The photo above left shows this in action. Although this works most of the time, it's not a universal solution – sometimes you just can't get as close to the job as you wish. On these occasions it is perfectly fine to use the iron to transfer solder to the tinned-only joint.

Arrange the solder crane as close to the work as possible and ensure that you can hold the wire in position with your hand. Touch the tip of the iron onto the end of the solder and load it with molten solder. Remove the iron from the solder and touch the solder laden tip onto the tinned-only joint. Watch as the heat transfer suddenly melts the solder on the tag and wire. As it does so the solder on the iron will leave the iron and mix with the solder already on the joint. Remove the iron and once again hold everything completely while it cools, blowing on the joint again to help it along.

As solder joints are so individual you need to deal with each job as it comes along. Practicing on some throwaway components can help to get a feel of the iron and solder.

If you choose to rewire tricky parts of the guitar electrics away from the instrument, then a small vice is an absolute must. Soldering a tone control capacitor across its tone pot, for example, is much easier in a vice; the same goes for wiring the 'between contacts' or cross-wiring for a series/parallel humbucker switch. The job is done quicker and more tidily if the switch is held firmly between the jaws of a vice because the contacts to be soldered are accessible and, thanks to the Anglepoise light, clearly visible and perfectly still.

The next patient is a standard no-frills USA-built Fender Stratocaster. Its problems are twofold: the back pickup is hard to select – switch position 5 works occasionally, mostly it just hums loudly; and the guitar hums when the musician takes his hands off the strings.

Hands off buzz

Any guitar that hums will have an earthing problem. The 'hands-off buzz' is probably down to a break somewhere in the earth circuit. When repairing any guitar with these symptoms, first check the wire which joins the strings at the bridge to the earth side of the controls – usually to the back of the volume pot casing. This wire is commonly called the 'string earth' and most passive guitars become hummy if this wire is broken or is making poor contact. >

1 **The 'crane method': hold the wire in position with thumb and little finger while guiding solder onto the joint**

2 **A dry solder joint to the earth tag is a problem that can contribute to unwanted hum**

3 Carefully resoldering the pickup earth return wire to a pot casing

With this Strat it's unlikely to be a problem at the bridge end of the wire. Fender changed their string earth design in the '70s, making a serious attempt to avoid such problems with a body-mounted solder tag and shielding paint on the inside of the body cavity. The new tag was positioned near the control cavity and was wired in two directions: one wire to the vibrato spring-claw, the other to the rear of the volume pot, with the tag also in electrical contact with the shielding paint. A nifty idea, because the earth tag sorts out many of the earthing problems within a Fender type guitar: firstly it tidies up the earth plane within the guitar by creating a single earth point to which all the relevant parts of the circuit can be connected; secondly, it enables the body cavity to be screened.

Adding the tag also protects the wire that runs to the vibrato spring claw from being yanked when the scratchplate is removed – a common problem with the original design. If you inadvertently pulled hard on the old type of string earth lead, it was possible to jar the solder joint on the spring claw enough to make it become one big dry joint, right where you need one the least. Resoldering this connection is very difficult as the large spring claw draws the heat away from the joint; a successful resolder of this joint requires serious cleaning and every bit of power the solder gun can provide. Adding the tag avoids this by moving the weak point to a more manageable position for soldering.

Make the switch

The second problem with the Strat, the intermittent, humming on switch position 5, is familiar: the contacts used for the bridge pickup (position 5 on the switch) are probably twisted out of alignment. If so, they could be touching the metal chassis of the switch when the bridge pickup is selected. If the chassis of the switch is not earthed then it could be making contact with the live or hot output of the switch and so humming when touched. In the worst case it could hum even if not touched.

Surgery time

Removing the scratchplate reveals that the string earth connection at the aforementioned tag has become a dry joint, probably through being tugged too much. The selector switch is infested with crud to the extent that the contacts used for position 5 are eaten almost half away (crud never sleeps). The only solution is to bin the whole part and replace it with a new switch. The earth connection to the rear pickup has also become a dry joint, and this is contributing to the hum in position 5. Resoldering the earth tag and the pickup earth return wire will cure the hum, and replacing the switch will bring the rear pickup back to life.

Dry joints

As you can see, dry joints were responsible for most of the problems with this guitar. Spotting them is an important part of troubleshooting electrical guitar problems. Fortunately, this is relatively easy: dodgy joints usually take on a mottled, dull grey colour, much like pewter or zinc, whereas a proper, electrically sound joint remains shiny and mirror-like. One way to pick out the baddies is with your Anglepoise light – if you arrange the light to shine down onto the scratchplate, good joints will catch the light and reflect it back, while dry joints remain dull and won't reflect much at all. This light method is a very helpful way to sniff out a problem, but testing the joint is best left to a multimeter.

Multimeters

Maybe you can get by without one of these gizmos, but even a simple multimeter can be very useful – and some work, on humbucking pickups for example, is pretty much impossible without one. Two kinds of multimeter are available: the old AVO-style analogue needle-type meters and the newer digital LCD readout type. I find that the needle-type is easier to read, while the digital types can only be read if you can look down on them.

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25 Ways To Upgrade Your Les Paul

From easy, zero-cost mods to tone-expanding wiring changes, clever vibrato technology and even head-to-toe vintage makeovers, there are many ways to personalise and improve your Les Paul. **HUW PRICE** reveals our pick of the very best

Even if you're disinclined to undertake woodwork or have at it with a soldering iron, there's still plenty of scope for modifying, customising and upgrading your Les Paul. Broadly speaking the categories break down into cosmetic changes, electrical mods, and hardware upgrades.

The iconic models Gibson made during the late 1950s do not enchant all Les Paul players, but for some it has become an obsession. Original examples are in short supply given that only 1500 or so were made, and the market value has sky-rocketed accordingly. Unsurprisingly, an industry of parts suppliers now serves the needs of Les Paul players wishing to create their own vintage replicas, and this is the mindset that drives most of the cosmetic changes.

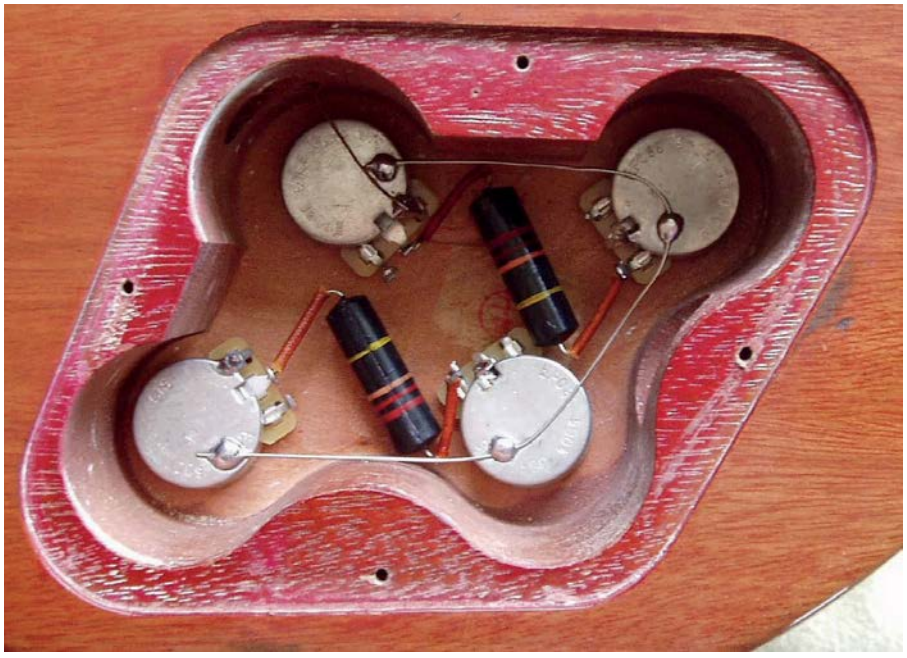
The vintage ethos drives many of the electrical modifications too, with circuit reconfigurations, capacitor tweaks and the ubiquitous PAF replica pickups. However, this is one area where Les Paul players need not be bound by 'vintage correctness'. There are easy and affordable ways to customise and expand your range of tones, and players are no longer restricted to conventional control layouts or even P90 and PAF-style pickups.

In the past many Les Paul players shied away from hardware upgrades because they were reluctant to drill holes in a quality guitar. Nowadays the range of bridges, tailpieces, tremolos and tuners that will slot right in place is extensive. However, you should be aware that USA-made Les Pauls are fitted with hardware that conforms to imperial measurements, whereas those of Far Eastern manufacture – like Epiphones and the various Japanese 'replicas' – require metric hardware.

Here are 25 of our top tips for modifying Les Pauls – or SGs, ES-335s and others. Some are costly while others are cheap, and many won't cost a thing. Have fun and don't do anything irreversible that you may come to regret. >

1 '50s WIRING

This is just about the simplest modification you can perform on your Gibson, or indeed any guitar – and it doesn't cost a thing. They call it '50s wiring because it's the way Gibson hooked things up until around 1962 or so, and the only actual difference was that they connected the tone control to the output (ie. middle) tag of the volume control rather than the input (ie. outer) tag. With '50s wiring you can turn down your volume control without the sound muddying up quite so much, and the volume and tone controls also become more interactive, which may be the reason why Gibson changed it. If you decide you don't like it, simply reverse the procedure.



This picture shows the first stage of a '50s style wiring installation. Note how the 'bumblebee' capacitors are connected to the centre tags of the volume controls.

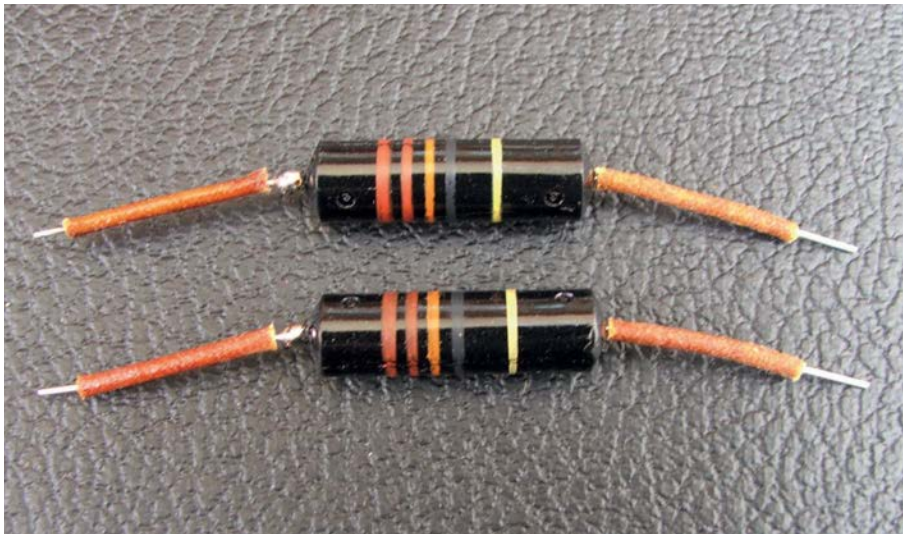
2 TAILPIECES

Gibson's first stop tailpiece – the ones fitted to the '50s collectors' guitars that cost the same as a decent apartment – was originally made from aluminium, but later on this changed to zinc, which remains stock on current models. Some players claim aluminium gives extra woodiness and more treble with a wider dynamic range, while zinc fans argue that their preferred metal has more low end and sustain. Others will tell you that they can't hear any difference whatsoever... but even so, it's a simple and reversible DIY modification. The Gibson version costs around £120, but alternatives from Faber, Pigtail, Gotoh, Kluson and others start from about £30. We believe aluminium sounds different, but even if you can't hear it, at least your Lester will be a bit lighter.

Fitting an aluminium tailpiece is a cheap and easy modification that improves the tone of a Les Paul for many players. Faber in Germany offer aluminium tailpieces with various degrees of relicing.

3 TONE CAP SWAPS AND UPGRADES

It is incorrect to say that tone capacitors have no effect on the sound of a guitar when the tone controls are fully up, because there is always some treble bleed when a tone circuit is installed... so the value of the capacitor will determine the frequency at which roll-off occurs. Some players are convinced that they can discern sonic differences between different types of capacitor of the same value. The originals were 0.022uF paper/oil types; repros are available or you can use Mallory 150s, Sprague Orange Drops or Vitamin Qs. Some like to experiment with different values too for increased or decreased treble roll-off. Our best advice is to experiment!



0.022uF paper/oil capacitors nicknamed 'bumblebees' were installed in original Les Pauls. Replicas are available but not all are paper/oil. Russian made K40Y and K42Y paper-oil capacitors are readily available cost effective equivalents.

4 COVER REMOVAL

This is one of the earliest mods players performed on their humbucker-equipped Gibsons (Clapton's Beano burst was a classic example). It was generally thought at the time that removing the covers made the pickups sound louder. In fact players who removed their covers were probably just hearing more treble, because the capacitive effect of the covers caused high frequency roll-off. Vintage nickel silver covers were very thin and kept treble loss to a minimum, while later covers, – especially thick brass ones – did the upper frequency response no favours. The principle also applies to Telecaster neck pickups, which can be de-muffled by snipping the bridging wire from the cover to the negative wire.

Covers are usually held in place with two blobs of solder. Use a Stanley knife to cut through the solder, being extremely careful with your fingers and the pickup itself, then lift the cover off. Here we see an 'uncovered' double black Shed PAF Daddy.

5 TOP WRAPPING

In addition to providing an anchor point for the strings, the stop tailpiece ensures that the strings have a suitable break-angle over the saddles. However, when the tailpiece is screwed tight to the body, the angle might be too sharp and the strings may end up contacting the back of the bridge, which increases the chances of string breakage. One solution is to feed the strings through the tailpiece from the pickup side and wrap them *over* the top of the tailpiece. Proponents claim that you get the tonal benefits of tailpiece-to-body contact coupled with more sustain and a slinkier playing feel.

This is one mod you can easily try for zero cost. Not everybody likes the result, but many players who try the 'wrap over' trick – including Bonamassa, Wylde and Gibbons – never go back.

6 NUT JOBS

Much is made of the type of material used for nuts. Traditionalists insist on bone, some prefer the slippery attributes of high-tech materials like Graphtech, while Lester players like Zakk Wylde famously prefer brass. Currently Gibson installs a variety of nuts depending on the model, including an unusual 'zero fret' device that allows player to adjust string height. Even so, a nut can only affect the tone of open strings, so the main reason for installing a new nut would be if the slots are inaccurately cut or they prove to be too deep after a re-fret. For vintage authenticity you might consider installing a 6/6 grade nylon nut. Pre-cut nylon nuts are available, but often at a steep price. Alternatively, you can buy a sheet of 6/6 nylon and make one up.

Discussions about guitar setup and playability often overlook the importance of a well-cut and properly slotted nut. This may be one for a professional luthier, but you can choose various materials. Here's one being made by reader Tony Berrington in correct '50s spec nylon.

7 NYLON SADDLES

Nylon isn't generally regarded as a tone-enhancing material, but here it is again. Les Pauls have always had metal saddles, and the originals were nickel-plated brass. Gibson's early Tun-O-Matic-equipped semi-acoustics had the same, but Gibson were fitting nylon saddles on the semis by the mid '60s. When comparing a '60 ES-330 with a '64 ES-330 we noticed the '64 had a sweeter and more resonant acoustic tone, and a quick bridge swap demonstrated that the nylon saddles were responsible. If you want a similar effect, try some nylon saddles on your Lester... or mix up metal for the wound strings with nylon for the un-wound ones, like Joe Bonamassa.

Joe Bonamassa favours nylon saddles for the plain strings on his Gibson signature model. He's a 'top wrap' kinda guy too.

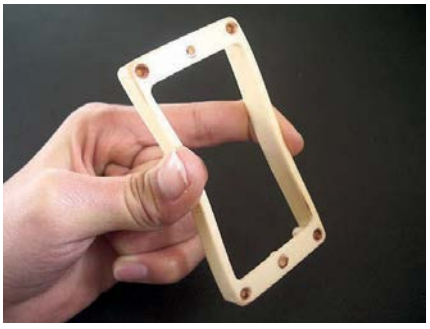
8 ALTERNATIVE PICKUPS

Due to the way that they're mounted, pickup-swapping was never a big thing among Les Paul players; chopping Fenders was always an easier and less scary proposition. These days things are simpler and all kinds of options are now available for humbucker and P90-equipped Les Pauls. If you want an early '50s tone, there are plenty of P90s in PAF mounts... or what about getting Gretschy with an 'English mount' and P90-sized Filter'Tron or DeArmond soundalikes from TV Jones. Alternatively, Seymour Duncan's P-Rails gives P90, PAF and Fender-like sounds at the flick of a switch.

The Seymour Duncan P-Rails has to be the most versatile drop-in pickup replacement for Les Pauls. It combines a P90 and a narrow single coil with a blade magnet. The coils can be used individually or combined in series for humbucker-type tones.

9 RELIC PLASTICS

Without wishing to offend anybody, getting into replica plastic parts for Les Pauls will lead you straight to the lunatic fringe of the relicing scene. Obsessives often engage in heated discussions about colour, texture and even smell. Put it this way, you will know your bendy Butyrate M69 rings are right when they smell of sick and they cost you a mere £200. Other über-expensive items may include single-ring tuner buttons and genuine Italian celluloid fingerboard inlays. Then there's knobs, switch tips and poker chips to consider. Vintage Haven, Montreux, Dead Mint Club, Monster Relic, Retro Vibe and Time Machine Collection can make your vintage replica look amazing... but it will sound exactly the same.



Relic parts like these Time Machine Collection M69 rings don't come cheap, but they look a lot better than the ones Gibson use.

10 TAILPIECE CLAMPING

Traditional tailpiece studs do not grip stop tailpieces at all – the only thing holding the tailpiece in position is the pull of the strings. Often you'll see tailpieces tilting forward, and it's claimed that better tone can be achieved by securing the tailpiece more securely. Tone Pros sell a range of replacement studs that comprise a stud and a separate cap that screws down onto the top of the tailpiece, while the Faber Tone Lock kits consist of replacement studs with spacer rings of various depths, so your tailpiece will be gripped and the original appearance is maintained – especially if you go for a reliced set. The spacers also allow you to set the tailpiece higher off the body for a looser feel.

The obvious way to keep the tailpiece fixed in position is to screw it flat to the body. Setting it higher softens the break angle, much like top-wrapping, but the tailpiece may need to be secured. Tone Pros locking studs provide an effective solution.

11 TUNER SWAP

Most of the '50s Les Pauls associated with big-name players have diecast tuners – with the exception of Billy Gibbon's Pearly Gates. Taking a Black & Decker to the headstock of a vintage LP may seem horrific nowadays, but diecast tuners require wider holes than Klusons and players were more concerned with keeping their guitars in tune than originality. Increased mass at the headstock may have enhanced sustain, too. Nowadays players are equally likely to retrofit vintage-style tuners, but you'll need conversion bushes to do it. You'll get vintage looks and livelier dynamics – and, contrary to vintage lore, decent Kluson-style tuners hold their tuning just as well as diecasts.

There was a time when players removed their Klusons and fitted Grovers and Schallers for improved tuning stability. These days the trend is the opposite, and here are a couple of Kluson-style repros from Fake 58 – one with a simple 'aged' button and the other with a shrunken and shrivelled button.

12 NO-LOAD TONE POTS

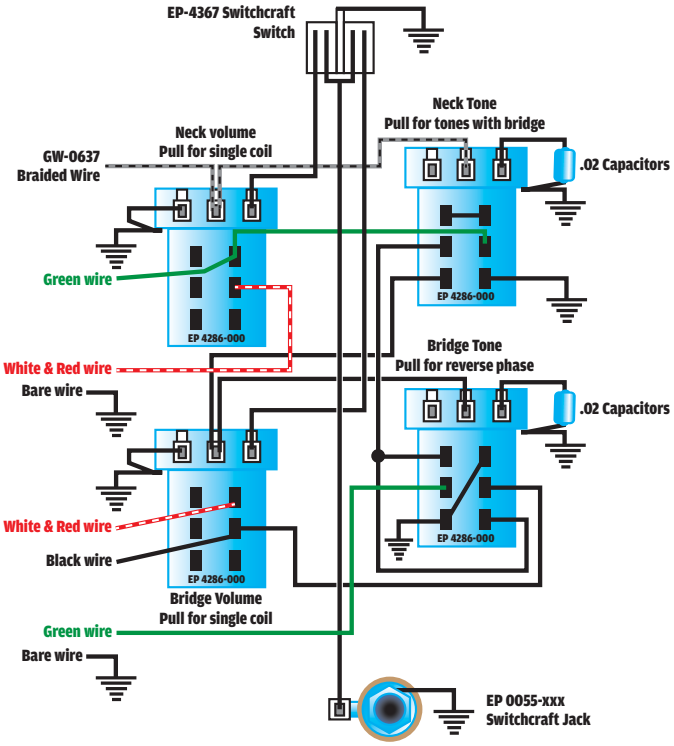
A lack of clarity and treble is a common Les Paul-related complaint, but what can you do when pickup-swapping isn't an option? Whenever a guitar is fitted with tone controls, there is always some treble bleed through the tone circuit (you can test this and see for yourself by disconnecting the tone circuit from the volume control).

Installing a 'no load' tone control potentiometer ensures that at the top of the turn the pot clicks into a position that disconnects it from the circuit and eliminates treble bleed. Turn the pot down, and it will function as a normal tone control. You can buy them or make your own, and you'll notice the biggest difference in the neck position.

Installing no-load potentiometers for your tone controls may help to make your Les Paul sound brighter and clearer. They're easy to buy, but it's almost as easy to make them yourself.

13 JIMMY PAGE WIRING

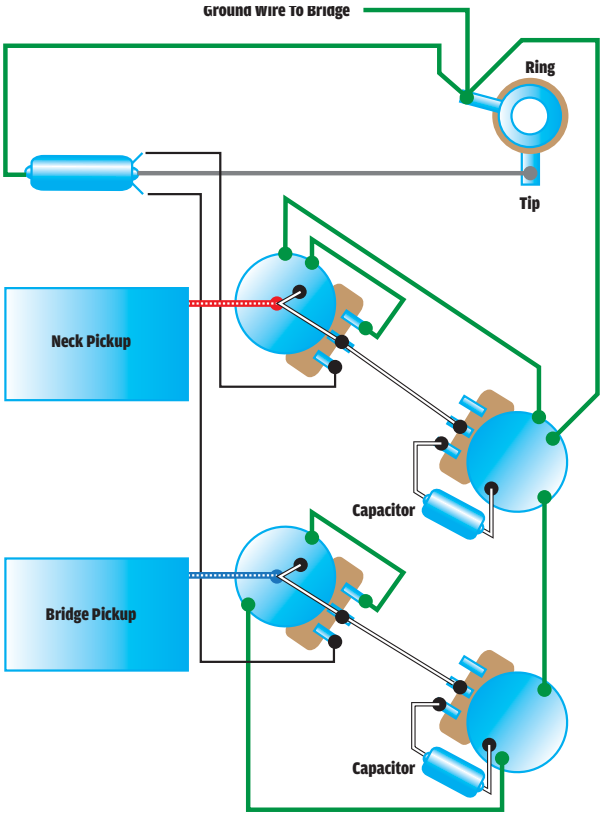
Any Les Paul with two humbuckers is actually equipped with four pickups – two pairs of single coils with each pair wired in series. When you think about the range of tones you can get from a regular Stratocaster, it's obvious Les Pauls have a lot of un-tapped potential. Jimmy Page certainly thought so, and he had four push/pull switches fitted in his 1960 Les Paul. The push/pulls under the volume controls switch between regular humbucker and single coil tones. The push/pull under the neck tone control is a series/parallel switch, and the one under the bridge tone control switches the pickups in and out of phase for Peter Green-style tones. If your pickups have vintage-style braided wires, they'll need to be replaced with multicore wires for this mod.



Jimmy Page used a lot of trick wiring with his vintage Les Pauls for out-of-phase and single-coil tones. A definitive schematic has yet to emerge, but here's one that will effectively do the job.

14 NO CUT OUT MOD

The regular Les Paul wiring scheme means that the controls are somewhat interactive. One of the oddities is the way that turning down one of the volume controls kills both pickups when the pickup selector is in the middle setting. Some players like it because you can do that stuttering staccato trick where you hit a power chord and 'play' it with the switch, but it drives other players bananas. Fortunately it's easy to de-couple the volume controls by wiring the volume controls backwards; just follow the diagram. The downside of the mod is more noticeable treble loss when you turn down the volume controls, so treble bleed caps may be required. Try 330pF for starters.



If you would like your volume controls to be completely independent and eliminate the cut out in the middle position, it's a simple case of reversing the input and output connections on the volume potentiometers.

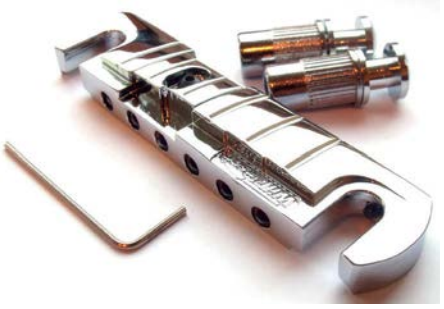
15 NO-HOLE BIGSBY INSTALLATION

Filled holes in the tops of vintage Les Pauls are the evidence of long-removed Bigsby vibratos. To some a Les Paul with a Bigsby looks just as incongruous as a Gretsch without one. Nevertheless, we think Lesters look the nuts with a Bigsby – and you can now install Bigsbys on Les Pauls without drilling any holes at all, thanks to a company called Vibramate. A specially-designed bracket attaches in place of the stop tailpiece to secure the front of the Bigsby unit, and the strap button screw clamps it at the back. This do-it-yourself installation can be done within minutes, but you'll need a fresh set of strings too.

The Vibramate system allows you to fix a Bigsby onto your Les Paul without drilling any holes because it utilises the tailpiece studs and the strap screw to hold the vibrato in place.

16 BRIDGE REPLACEMENT

Early '50s style Les Pauls and Les Paul Juniors had wrap over tailpieces, so intonation can be compromised. Fortunately wrap over replacement bridges with adjustable intonation are readily available. Vintage fans generally prefer ABR-1 style aluminium Tun-O-Matic bridges with brass saddles to the later all-zinc Nashville bridges. They can be swapped, but they require thumbwheel posts with a different diameter. Browns Guitars and Faber offer the necessary conversion posts. For replacement wrap over bridges and ABR-1 replicas try Wilkinson, Pigtail, Badass, Hipshot, Schaller, Gotoh, Tone Pros, Callaham and Gibson too.



Trevor Wilkinson's take on the wrap-over tailpiece is sleek and elegant. It has a movable saddle for the B and G that gives you a much better chance of achieving accurate intonation.

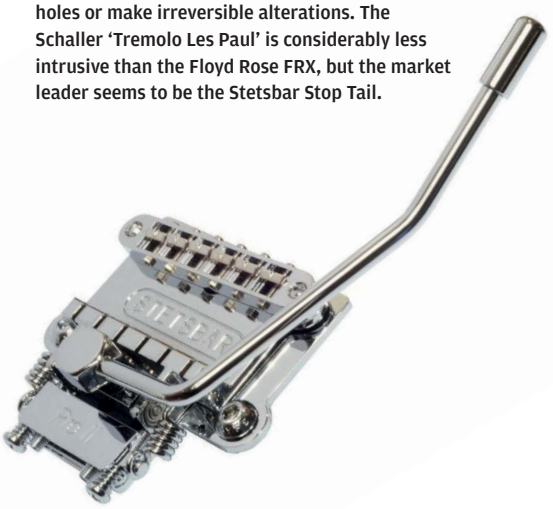
17 MULTI-POSITION SWITCH

Installing extra switches in Fenders was never a cause for concern because if you changed your mind, you could always buy a new pickguard to replace the one you had perforated. Understandably most Les Paul owners have baulked at the idea of drilling holes in their guitars, so the options for extra pickup configurations have largely been confined to push/pull and push/push switches – so the recent introduction of a six-way toggle switch that fits in place of the regular three way is an exciting development. Called the Free-Way Switch, it provides Lester players with countless options. Jimmy Page had one installed in the Les Paul Custom he used for the Ahmet Ertegun tribute concert, and they're manufactured here in the UK.

The six-way Free Way switch was recently introduced by the UK's NSF Controls. It means you can add all kinds of options to your guitar without altering its appearance or making the controls too fiddly.

18 ADDING VIBRATO

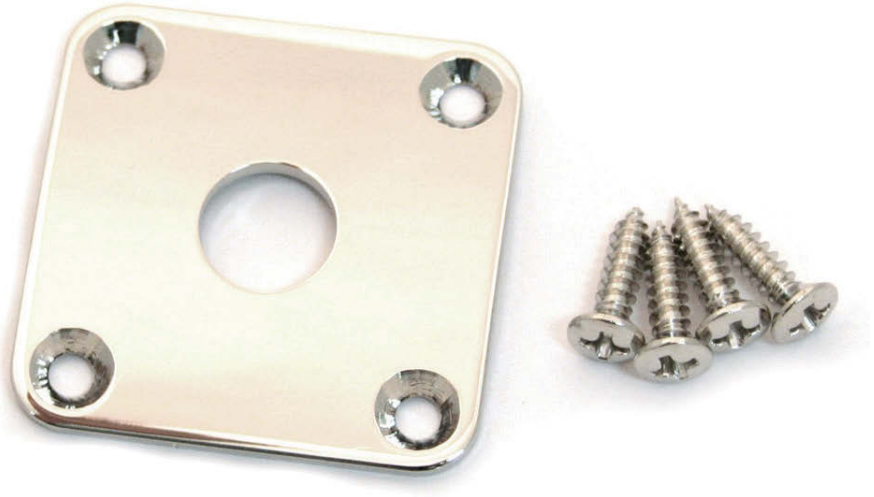
Key to the initial success of Paul Reed Smith has to be his hybridisation of the Les Paul and the Stratocaster, combining traditional Les Paul tones and vibe with Stratocaster ergonomics and a vintage-style trem that actually stayed in tune. The timing was perfect for a generation grown weary of day-glo Superstrats. Fortunately there are now several types of vibrato that can be fitted to Les Pauls without any necessity to drill extra holes or make irreversible alterations. The Schaller 'Tremolo Les Paul' is considerably less intrusive than the Floyd Rose FRX, but the market leader seems to be the Stetsbar Stop Tail.



Let's face it, nobody in their right mind would rout huge holes in the body of a Les Paul to mount a Strat-style vibrato, and Bigsbys aren't for everybody. The Stetsbar has long been the option for players who want to mount a proper whammy bar on a Les Paul.

19 METAL JACK PLATE UPGRADE

If a pickup fails or you break a string, you will be able to keep playing – but if your guitar output fails, you'll find that a Les Paul is not an ideal choice for an 'unplugged' performance. Every guitar design has its weak spots and the jack plate is the Les Paul's because the slim plastic plate is all too easy to snap. The solution is simple – a metal replacement. This is a cheap and reversible modification but try to ensure the screw holes of the new plate will line up with the old one before you hit 'buy it now'. The only tools required are a crosshead screwdriver and something to tighten up the jack nut. If you want to keep the original look, simply install the plastic plate on top of the metal one.



If you wish to buy a metal jack plate, be sure to double-check that the screw holes will line up with those of the original. If in doubt, contact the retailer for more information.

20 MAGNET SWAP

Various types of magnets are used in pickups, and they all sound different. The most common magnetic alloy is Alnico, and P90s and humbucker pickups usually have Alnico II, III, IV or V. Powerful ceramic magnets are also popular with rock players who prefer high output with plenty of brightness. If you want softer vintage tones, extra brightness or higher output and more aggression, it's cheaper to swap magnets than swap pickups. Humbuckers have one magnet and P90s have two, so remove the cover (if necessary), loosen the backplate and slide them out.

Pickup manufacturers may be reluctant to sell you magnets, but suitable alternatives are available from Stewart-MacDonald and Sensmag Inc. Here's a rough-cast A4 magnet being slid into position in a Shed PAF Daddy.

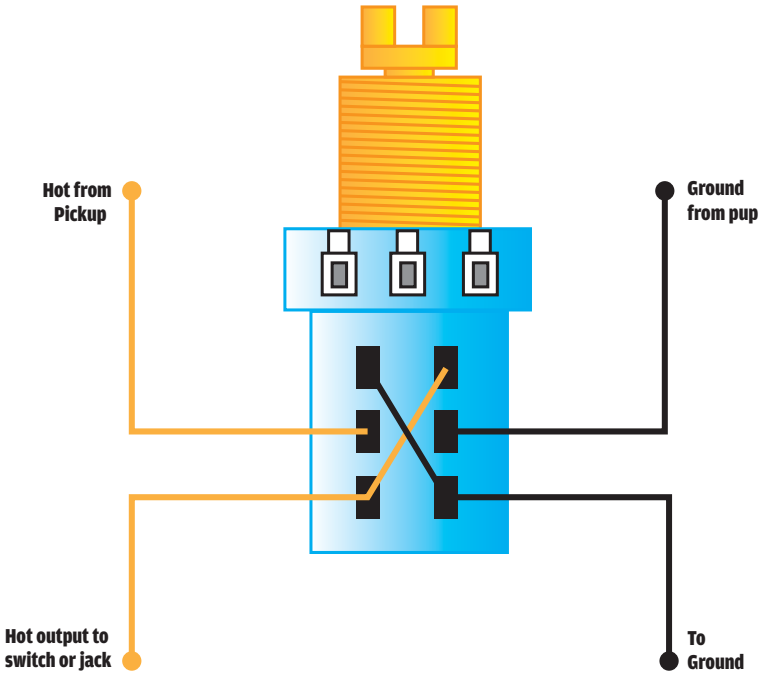
21 SETTING THE PICKUP HEIGHT

Humbuckers have screws at both ends to allow you to adjust the height of the pickups. Similarly, soapbar P90s have two small screws passing through the covers that do the same job. The proximity of pickup coils to the strings has a massive effect. Setting the pickups very high can make them sound overly aggressive and midrangey (the magnetic pull may even reduce sustain). When pickups are set lower the tone can be sweeter and more open, but they can sound dull and unresponsive if set too low. To optimise your tone the only tools you need are a screwdriver and your ears. Take time to experiment before buying a new set of pickups.

Pickup height is a vital ingredient of the fine art of setting up a guitar. Many players don't realise the huge effect it can often have, and go chasing the latest, hippest pickups without first making the most of the ones they've got

22 THE PETER GREEN MOD

During his time with Fleetwood Mac, Peter Green's Les Paul had a very distinctive sound in the middle position because the two pickups were out of phase. There are two ways you can replicate this. After removing the cover of one pickup (we'd suggest the neck), slacken off the baseplate, slide out the magnet then flip it around (not over) to reverse the magnetic polarity relative to the coil. Tighten the base plate up, refit your cover if you use one, and you're done. Alternatively you can flip the phase electronically by reversing the hot and cold connections. This can be hard-wired or switchable.



If you don't want to remove the cover from your pickup, you can reverse its polarity electronically. This can be done permanently or it can be linked to a switch to give you the option

23 REBUILDS

It is widely acknowledged that some of Gibson's current Historic Collection models are the finest guitars they have made since the 1960s but some owners want even more authenticity. A company called Historic Makeovers offers various 'packages' that include nitro refins with aniline dyes, authentic fading, relicing, neck reshaping, top re-carving and celluloid inlay replacement. Optional extras include Brazilian rosewood boards, trussrod replacement, Royalite rebinding, neck re-setting and nylon nut replacement. Prices start from $2015 and customers supply their own guitars. Converting early '50s Les Pauls to late '50s specs has also become popular of late – the premise being that 'the tone' is in the old wood.

Buying a high-end Gibson Les Paul reissue then sending it to Historic Makeovers to have it stripped, dismantled, rebuilt and refinished is not inexpensive, but it's a lot cheaper than a real '50s Les Paul. Here's a specially treated R9.

24 PAF REPLICAS

A desire to recreate the looks and tones of late 1950s models seems to inspire the vast majority of upgrades, and success is largely dependent on the pickups. Unfortunately, PAFs seem to be the hardest pickups to get 'right'. Certain key ingredients are well understood, and these include plain enamel magnet wire, butyrate bobbins, maple spacers and 2.5" magnets. Leaving the coils unpotted is vital too, but the real voodoo part involves getting the tension of the winding exactly correct and knowing how much to offset the coils. There are a handful of manufacturers whose PAF replicas are pretty spot-on, but be warned that the truly authentic tone of PAFs doesn't always conform to expectations.

By and large, replica PAF builders have proved more adept at recreating the look than the tone... but, even so, there are a select few that have managed to nail both. Here's a real '50s PAF with that iconic decal.

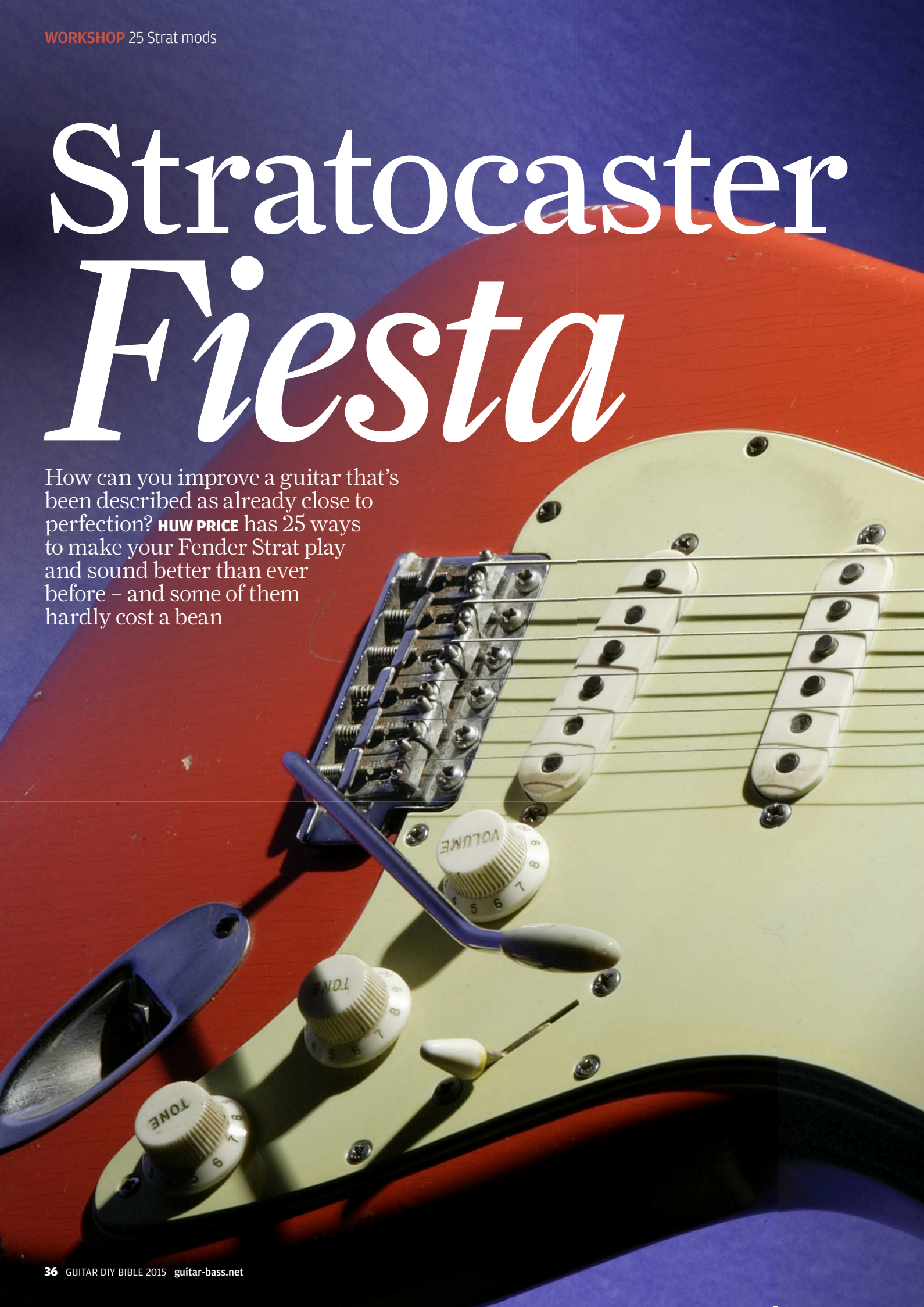
25 POT SWAP

The value of volume pots does have an effect on the sound of guitars. As a rule of thumb, lower-value pots equate to reduced treble (Fender use 250K pots to sweeten up their single coils). 500K was always the stock value for volume and tone controls in Gibsons, but many Les Pauls are fitted with 300K volume pots and some have 100K tone pots. If your LP sounds too dull and dark, measure the volume pots and install 500K replacements if 300Ks are fitted. Conversely, 300K pots will help to smooth out over-bright trebles. Some players find the balance they like with a 500K pot for the neck pickup and 300K for the bridge. CTS pots cost around £5 so it's cheap to experiment.

You can buy control pots from suppliers like Allparts UK, but make sure the shafts are long enough for an arch-top Les Paul. Alternatively, check out pre-wired control assemblies from companies like Emerson Custom Guitars.

Stratocaster Fiesta

How can you improve a guitar that's been described as already close to perfection? **HUW PRICE** has 25 ways to make your Fender Strat play and sound better than ever before – and some of them hardly cost a bean



There was a time when vintage Fenders were thought to sound superior to newer ones simply because they were old, and most players were content to leave it at that. As the prices of vintage Fenders went stratospheric, the guitar community began to ask why the old ones sounded different. Could those characteristics be replicated with newer instruments?.

Well, maybe, yes. It became apparent that various changes had been made to Fender's manufacturing methods and materials. In retrospect, 1965 was not 'year zero' for Fender because these changes occurred gradually – even if most were instigated by CBS bean-counters.

Pickups and woods have been subjected to close scrutiny, but only now are players becoming aware of the significance of seemingly minor electronic components, plus bridge blocks, saddles and nut materials. And it's not all about vintage tone; a proper understanding of the way the component parts fit into the formula will help you to make informed decisions about the modifications that will make your Stratocaster play and sound the way actually you want it to.

The purpose of this Guitar & Bass article is not to list all the fabulous aftermarket accessories and relic'd plastics that you can solder into or screw onto your Fender Strat. The emphasis is on optimising the basic instrument, and many of these modifications won't cost you a thing. Others are relatively cheap, and we'd advise you to investigate all the options before spending big money on exotic parts... because with a few judicious tweaks, a bit of basic wiring and some routine maintenance, that old Strat may yet surprise you. >

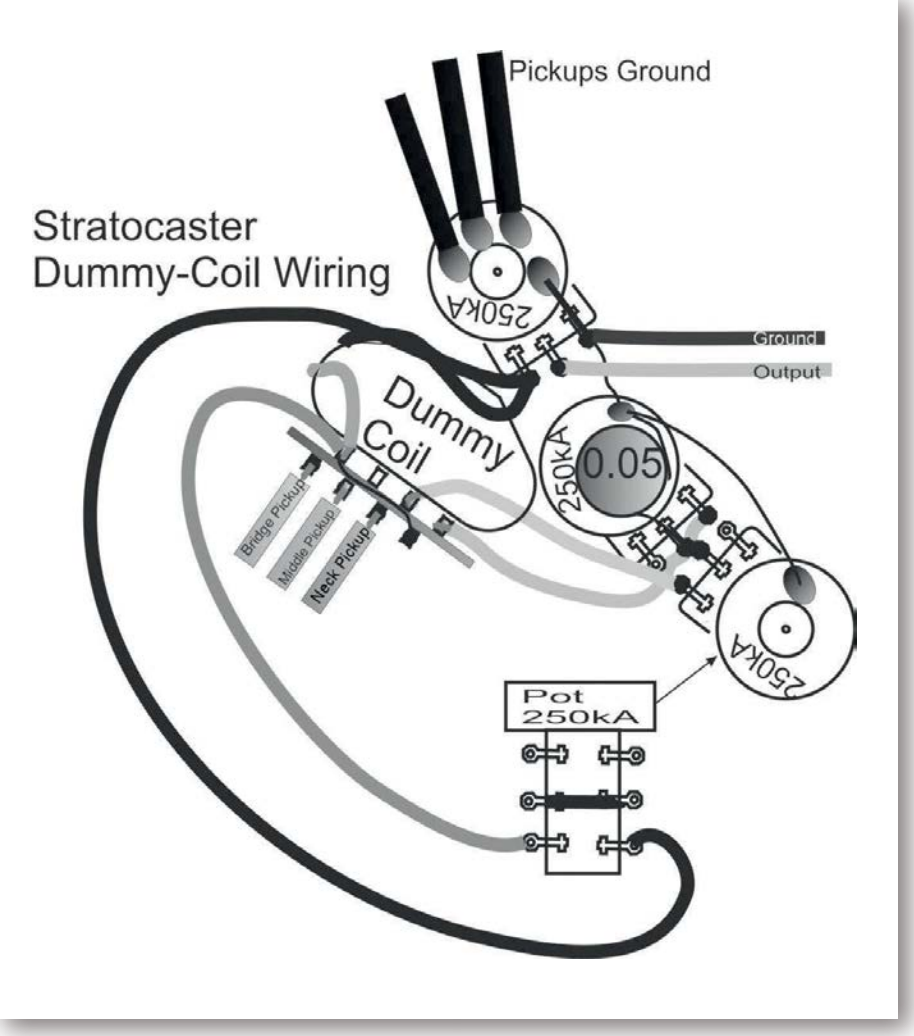
1 BLOCK THE BLOCK

Some Strat players never use the vibrato – Robert Cray and Billy Gibbons prefer hardtail Strats – but most consider the springs to be an essential component of the guitar's sound. So how can you have a trem-loaded Strat that you can be tuned up in a single pass and won't go out of tune when you snap a string? Simple: tighten the spring claw, place a lump of wood between the bridge block and the back of the trem rout, and slacken off the claw to allow string tension to wedge it in place. It's simple, it's cheap, and it works. Just ask Eric.

Not a trem fan? Using five springs, tightening the spring claw and wedging a piece of wood behind the block will give you hardtail tuning stability with spring-loaded tone.

2 BEAT THE BUZZ

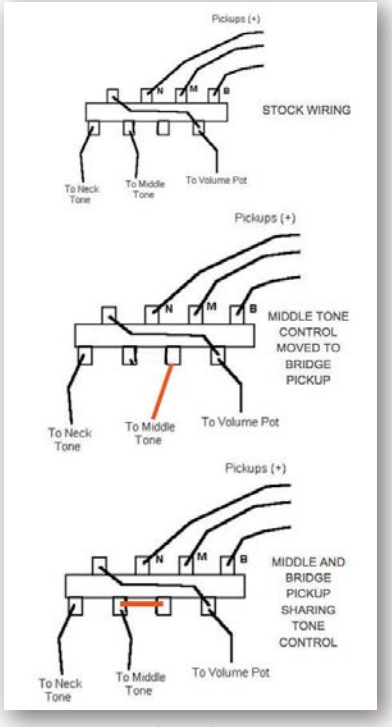
All guitars with single-coil pickups are prone to picking up noises, and Stratocasters will buzz and hum depending on the environment. Fortunately, there are ways to quiet things down. The simplest is to fit a RWRP pickup in the middle position, but this will only hum-cancel in positions 2 and 4. Some advocate lining the pickup and control routs with copper foil. Allparts sell sticky-backed copper, but you have to join all the edges with solder because the adhesive is non-conductive. Many pro players have installed dummy coils, and they feature in some Suhr models; you can remove the bar magnet from the underside of a cheap pickup and use it as a dummy coil. Ultimately, though, the only sure-fire way to silence a Strat is to install noiseless pickups such as Lace Sensors or Kinmans.



The suggested position for a dummy coil connected to a regular Strat circuit with an in/out switch.

3 BRIDGE TONE CONTROL

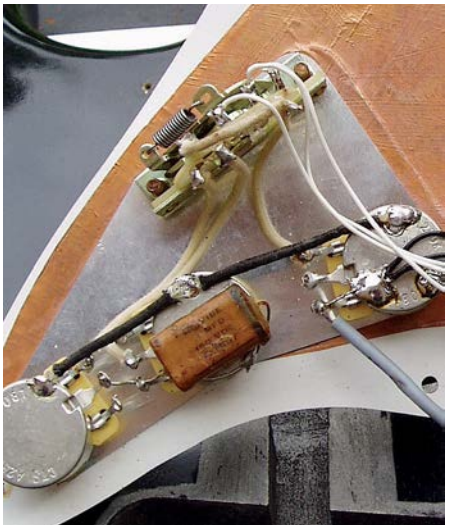
Many have wondered why Fender chose to provide tone controls for the neck and middle pickups but neglected to provide treble roll-off for the pickup that actually needed it most. It's easy to remedy this oversight, and if you can solder, it shouldn't cost a thing. Method 1 is to swap the middle (or neck) pickup's tone control to the bridge pickup; method 2 is to add a jumper wire so the bridge pickup can share one of the other tone controls. Problem solved.



To connect the bridge pickup to a tone control, most modders move the middle tone control connection over or use a jumper for the bridge pickup to share the middle tone control.

4 CAPACITOR VALUE

Pickup upgrades are often an attempt to sweeten the sound, but most of us overlook the tone capacitor. Fender initially installed 0.1uF caps – firstly paper/oil types, then later ceramic discs. Around 1964 the cap value was changed to 0.047uF. Treble is always lost through tone circuits – even when they're supposedly off – so the capacitor value is significant. A Strat will sound brighter with a 0.047uF cap than a 0.1uF. If you're chasing 'vintage tone' it's worth spending 20p on a 0.1uF capacitor before spending £200 on a set of pickups. If you want your Strat to sound brighter, try a 0.022uF cap.

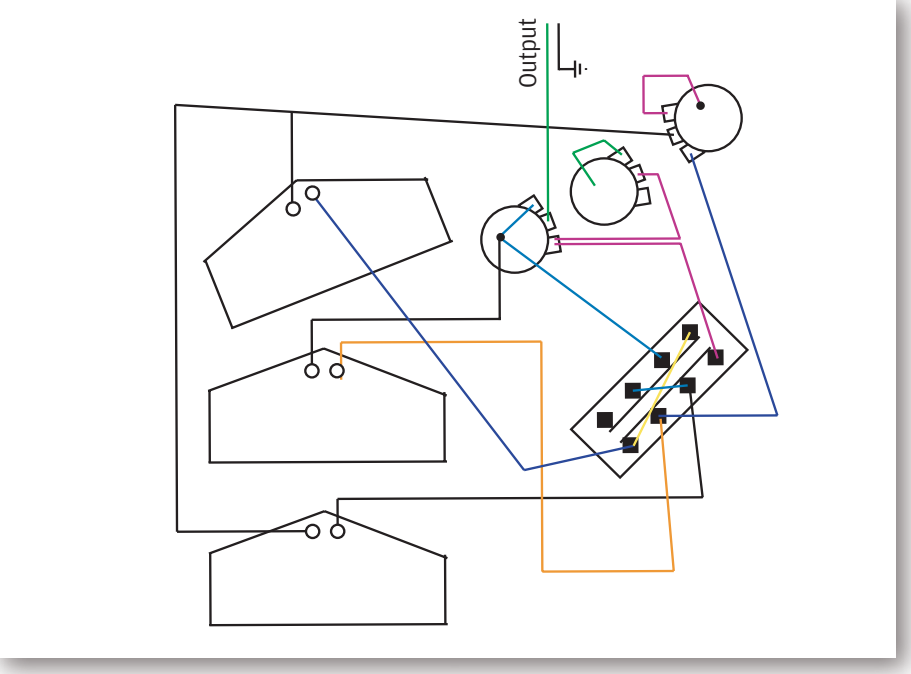


This is a reproduction of Fender's original paper/oil 0.1uF capacitor. The treble will sound vintage-correct with this value – or you can fit a 0.047uF or a 0.022uF for extra brightness.

5 DAN ARMSTRONG WIRING

Dan Armstrong devised a parallel/series wiring mod for Strats that uses the 'middle' tone control as a blender/mixer. With the blend control at 10, you get all five regular pickup settings. When it's rolled fully back you get a H/S/H configuration – the middle pickup combining in series with the neck and bridge in the front and back positions.

These pseudo-humbucker settings are fatter and louder while settings 2 and 4 are genuinely out of phase. You can explore semi-series and semi-out of phase tones as well, because there's a blender rather than a switch. The new layout is simple to operate and if you're content with master volume and tone, it's a great way to use that spare control.



This Dan Armstrong mod provides four extra tones, with pseudo-humbuckers in the neck and bridge. It sounds fantastic, it's easy to use, and your guitar's appearance remains unchanged.

6 SWINGING ARMS

Over time vibrato arms can become loose. If they develop too much play then they rattle back and forth when you use them, causing noise and making it harder to achieve a smooth vibrato – and you can certainly forget about Jeff Beck levels of precision. There are a couple of tried and trusted remedies, though. Some players like to drop a small spring into the bottom of the arm hole in the block so that as the arm is tightened it presses against the spring and feels a bit more stable. Another popular fix is to wrap PTFE tape around the arm thread. You can buy this tape from plumbers' merchants and it's very cheap – which is just as well, because the tape will need to be refreshed every so often. For a more permanent solution, check out the innovative trem arm from the UK's Staytrem.

Some well-placed tape can tame a loose tremolo arm – but you'll need to replace it often.

7 HEIGHT ADJUSTMENT

The term 'Stratitus' is used to describe the odd-sounding tuning anomalies many Strats exhibit on the low E string as you play above the 12th fret. This is caused by excessive magnetic pull from the pickups inhibiting string vibration, and pickups that are set high will make things worse. Don't assume that your Strat came out of the factory adjusted to perfection – the proximity of the coils to the strings has a significant effect on tone. Set the pickups high and they'll make your Strat sound bright, loud and aggressive; set them lower and the tone should open up, with sweeter trebles and more dynamic response. Set them too low, and your Strat will sound dull and lifeless. All three pickups have height-adjustment screws and they're there to optimise tone and balance the levels of the pickups. Let your ears guide you.

The pickup height adjustment screws are there to be used. If you're nervous about doing this, attaching a small piece of masking tape to the ends of each cover and marking the pickguard level with a pencil will allow you to return easily to your original settings.

8 INDUCTANCE PLATE

Turning Telecasters into Tele/Strat hybrids is common enough, but fewer players have attempted to Tele-ise their Strats with a replacement bridge pickup – Lowell George being an honourable exception. These days it's a cheap and easy mod that requires a metal inductance plate to be attached to the underside of a regular Strat bridge pickup. These can fatten, focus and generally beef up your bridge pickup tone. Steel plates sound different to copper and so forth, so do some research beforehand to decide what appeals to you. Suppliers include Fralin, Shed Pickups, Singlecoil.com and Oil City.

An inductance plate will make your Strat's bridge pickup sound more like a typical Telecaster. They're cheap and easy to install.

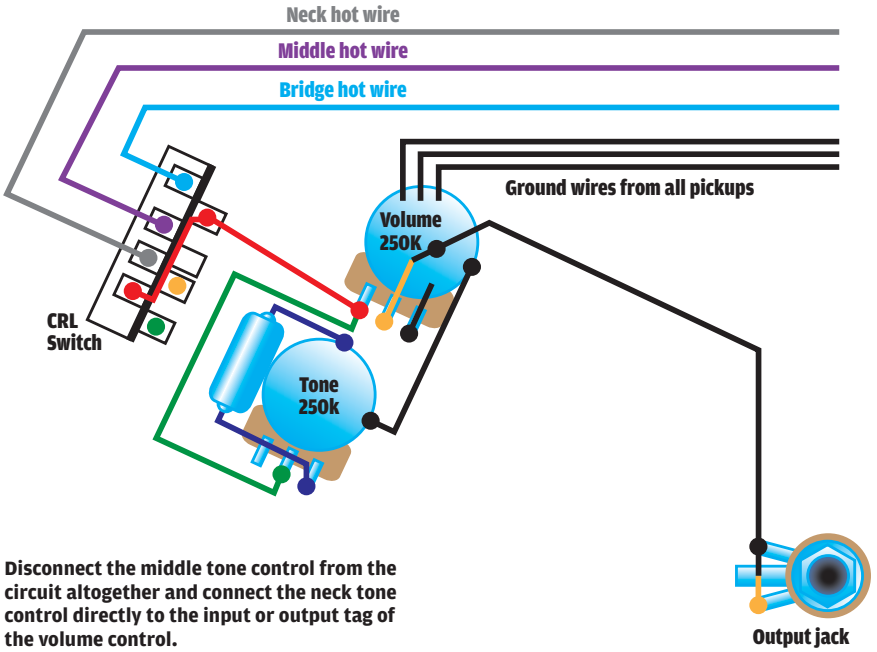
9 LUBRICATION

Friction is the enemy of stable tuning. This has been well understood for decades, and excellent results are achievable with traditional petroleum jelly and graphite from soft pencils. Other DIY solutions include silicon grease, Chapstick and 'O' ring grease, while specialist guitar products include Big Bends Nut Sauce, Graphit All and many more. Although they all do much the same job, the guitar products are designed for accurate and mess-free application. Potential sticking points include nut slots, the point where the strings contact the saddles and beneath the string trees. Lube up as part of your string-changing routine.

Big Bends Nut Sauce is a popular guitar lubricant. The syringe and micro brush make it simple to apply and it might help to keep tuning solid.

10 MASTER TONE CONTROL

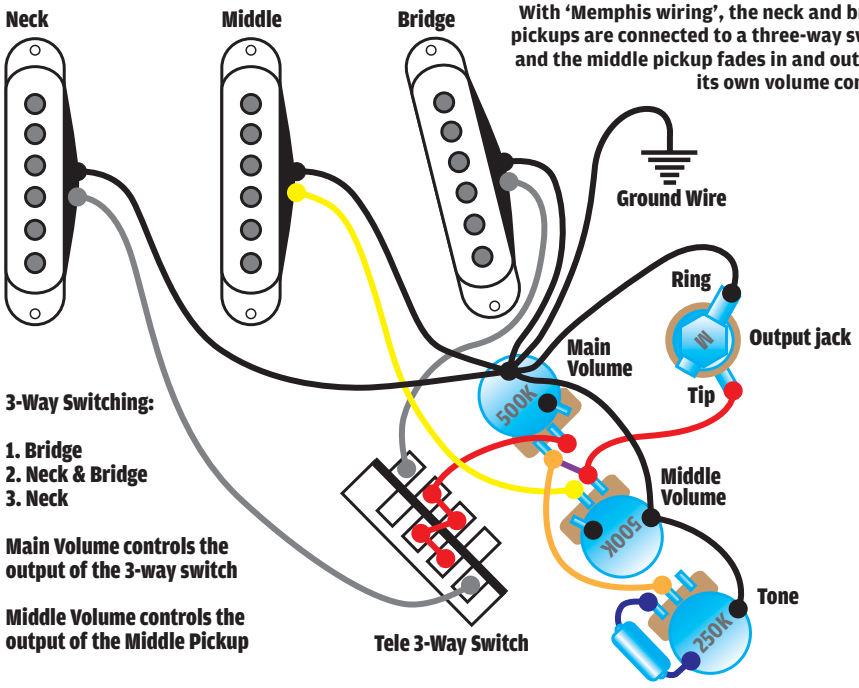
Strat players have long struggled with over-bright bridge pickups, prompting aftermarket pickup makers to devise 'balanced sets'. Many deliver, but the underlying cause is not addressed. Stock Strat pickups *are* balanced, but the stock circuit isn't, as only the neck and middle pickups bleed treble through the tone circuit. Changing to a master tone arrangement is a simple modification that 'balances' the treble response of the pickups and frees up the second tone control for trick wiring. If you connect the master tone control to the output (centre) tag of volume control rather than the input, the ratio of guitar signal to treble bleed remains consistent regardless of the position of the volume knob. Many find it renders treble bleed capacitors superfluous – and you can try it on your Tele too.



Disconnect the middle tone control from the circuit altogether and connect the neck tone control directly to the input or output tag of the volume control.

11 THE MEMPHIS WIRING TRICK

In the days of three-way switches, players were aware of the Strat's in-between settings but it was hard to make the switch stay put. Here, the middle pickup is disconnected from the volume control and the switch, leaving a Tele-type neck/both/bridge arrangement with master volume and tone controls. The spare tone control becomes the middle pickup's volume. You can still have all your regular Strat settings plus all three pickups in parallel and a great sounding neck/bridge combination. It's known as 'Memphis Wiring' because this was the preferred configuration of Sun Records legend Roland Janes.



With 'Memphis wiring', the neck and bridge pickups are connected to a three-way switch and the middle pickup fades in and out with its own volume control.

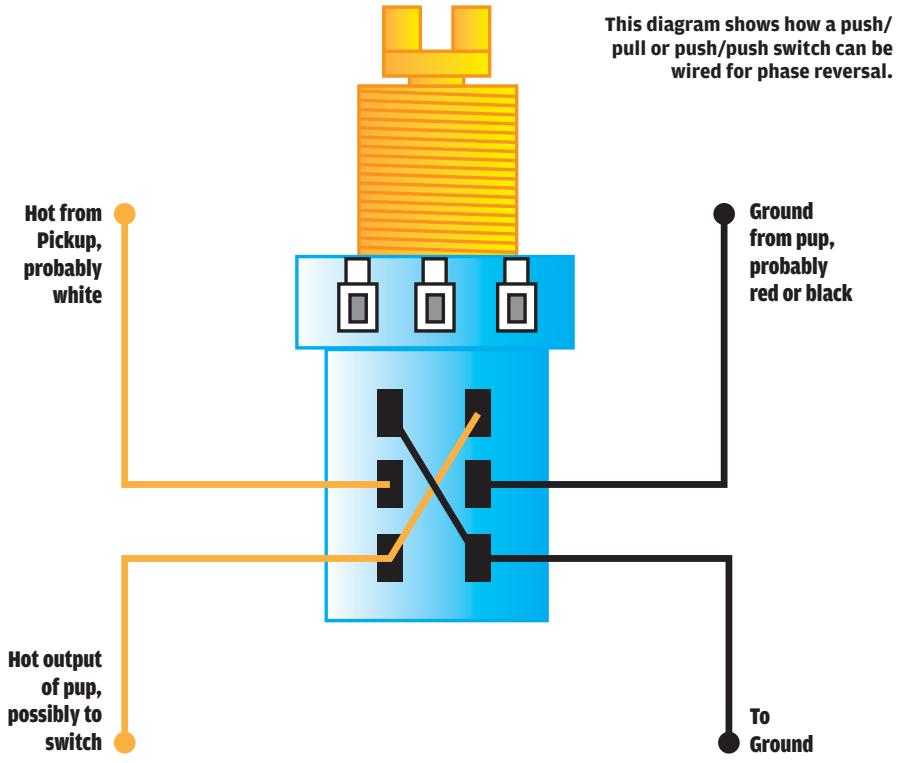
12 NUT JOB

Friction is the cause of most tuning problems, and rough nut slots are a common source of friction. Listen for clicks and pings from the headstock area as you tune up. Budget Strats often come with plastic nuts, which aren't good for tone or tuning; why not consider upgrading to bone or a self-lubricating graphite nut from Graphtec? Trem king Jeff Beck prefers a roller nut, but standard nut slots must be altered to fit one. If you already have a bone nut, try wrapping a length of string with 1200 grit wet and dry paper and smoothing the slots. After protecting rosewood fingerboards with masking tape, buff the nut and slots with chrome polish.

Roller nuts are popular with heavy vibrato users because they provide a friction-free ride. The drawback is that in order to fit one, the nut slot will need to be widened.

13 OUT OF PHASE SWITCHING

Although the in-between settings are often referred to as 'out of phase', it's really two pickup coils working together in series. There's a degree of phase shift because they're picking up string vibrations from different areas of the string, but the pickups are actually in phase electronically. True out of phase switching means reversing the positive and negative connections of one pickup. Individually the pickups will sound the same, but in combination the thinner, scratchier, honkier sound is useful for getting clean sounds high in a mix without eating up too much frequency space. It's a tone heard on funk and old Motown records, and it can be brutally lo-fi through a fuzzbox.



This diagram shows how a push/pull or push/push switch can be wired for phase reversal.

14 PICKUP UPGRADES

We believe a pickup upgrade can provide the biggest improvement of all, but it shouldn't be regarded as a cure-all – there are easier and cheaper upgrades that you should perform first. Vintage tone enthusiasts may want scatterwound coils and they should check out the various types of alnico and slug staggers Fender used in different eras. Formvar magnet wire was used prior to the CBS takeover and plain enamel thereafter. All these things make a difference. Hot wound single coils and drop-in humbuckers with coils in stacked and side-by-side configurations will make your Strat far more powerful. Drop-in P90 soundalikes are also available, as are low-output Danelectro-style lipsticks.

Single-coil sized dual rail pickups such as DiMarzio's Air Norton S solve hum problems and boost output, without extra routing.

15 NECK POCKET CLEANUP

To resonate together as one, the body and neck of a guitar should be coupled as tightly as possible. Wood-to-wood contact is ideal – but this isn't the way things generally turn out. Pop the neck off most Strats and you'll often find various horrors in the pocket. A shim is often needed to achieve an optimal neck angle, and it's accepted practice, but rubber grommets, cardboard and scraps of sandpaper are not ideal. Try a sliver of hardwood veneer if you need to shim. Many necks have labels and stickers in between the screw holes. Peel them off and clean up any residual stickiness. If you're spraying a body, consider masking of the neck pocket so the wood remains exposed.

We recently found this plastic cut-off in the neck pocket of a Strat. Needless to say it was binned.

16 PUSH-PUSH SWITCHES

Push-pull switches – a switch box combined with a potentiometer in a single unit – have been around for a long time. The control knob works conventionally but it can be pulled up or pushed down to use the switch mechanism. The switch can perform any number of functions, some of which are detailed in this article. The problem for Strat players is that stock tapered knobs are not easy to grip and you can't get your fingertips underneath if they are tight against the scratchplate. The solution is simple – fit a push-push switch instead, so you push down to switch on, and push down again to switch off. It's fast, effective and means you don't need to drill holes in your pickguard.

This push/push switch is mounted on a pot casing. The standard value for Strats is 250K.

17 SADDLES

Most of the changes that were instigated at Fender by the CBS management were intended to reduce costs rather than make real improvements. Like many other components, the quality of string saddles fell when a cheap alloy nicknamed 'monkey metal' replaced the bent steel. For vintage tone, steel saddles may provide a noticeable improvement; other popular choices include stainless steel, bass and titanium. Heavy trem users may wish to investigate roller saddles, or Graphtecs. They all have different tone and sustain characteristics, so do your research and make sure the saddles you choose are compatible with your Strat's string spacing.

There are countless options for upgrading Strat saddles. These Graphtecs have built-in piezo pickups that are intended to provide Stratocasters with an 'acoustic' option. Pete Townshend is known for using these.

18 ADDING A SHIELDING PLATE

This is something we discovered by accident while trying to replicate the huge, warm tones of a genuine '63 Strat with an '83 Tokai Goldstar. Acoustically there was little to choose between them, but despite trying various sets of pickups and correcting the tone cap, the sound wasn't quite there. By chance we had an aluminium shielding plate hanging around – just like the ones Fender used between 1959 and 1967. On a whim we fitted the shielding plate and the midrange acquired a thicker, chewier and sweeter vintage loveliness. We can't offer a scientific explanation but if you're chasing SRV tone, a £10 aluminium shielding plate should be the first item on your shopping list.

A 1960s-style aluminium shielding plate does influence the sound of a Stratocaster. Try one before buying an expensive set of handwound pickups.

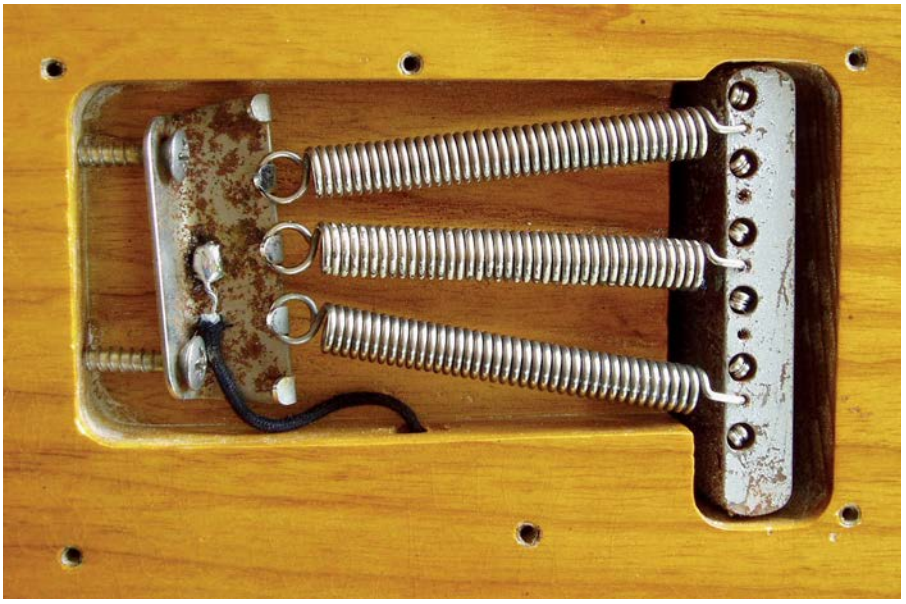
19 SHIM THE TREE

This may help your Strat to stay in tune a little better. In lieu of an angled headstock, Fender use string trees to achieve the necessary break angle over the nut. We have noticed plenty of Strats with string trees screwed flat to the front of the headstock, making the break angle greater than it needs to be and increasing friction under the tree itself. Put a spacer under the string tree to reduce the angle and straighten the string path between the nut and the tuners – that's what Fender always did. Alternatively you can bypass the string tree completely and achieve the necessary break angle by winding the B and E strings all the way down to the bottom of the tuner post.

The string tree on the left is shimmed, while the one on the right is flat to the board. We'd recommend shimming both in order to reduce friction and avoid tuning issues.

20 SPRING COVER REMOVAL

This one is a source of contention because some claim to hear the effect of a removed spring cover while others can't hear any change at all... and even the advocates admit it only works on some Strats. Either way, it's free and totally reversible. Simply unscrew the six screws holding the spring cover onto the back of the body and remove it. If your guitar sounds more resonant and responsive, then congratulations on completing a successful upgrade. You'll probably find string changing a lot easier too. If your guitar sounds just the same, feel free to put the cover back on.



Some claim to hear a difference when they remove the spring cover; others don't. It's worth a try.

21 STEEL TREM BLOCKS

Fender originally used 10oz cold rolled steel (CRS-1018) blocks with shallow holes for the ball ends, and these are generally regarded as being effective tone enhancers. Use a magnet to test if your block is steel – if the magnet falls off, it isn't. Callaham's vintage-spec blocks are excellent but expensive in the UK. Domestic equivalents are available from Wudtone, and Kevin Hurley sells his blocks on eBay, both relic'd and non-relic'd and in narrow and wide spacing. With either of these, you should get extra brightness, definition and sustain. Even if you don't plan to change your block, it's worth popping off the bridge plate to scrape off any paint that may be applied to the top.

This cold rolled steel Hurley relic trem block weighs a vintage-correct 10oz. It was made in the UK, and at a shade under £30 it's less than half the price of some American made blocks.

22 STRING OUTER-SPACING

Many players experience a problem with their E strings slipping off the fingerboard when they apply finger vibrato. On old guitars this can occur because the neck has become worn through years of playing or overly aggressive fretwork, but some contemporary Strats – like the Yngwie Malmsteen signature model – exhibit the very same problem. The Callaham V/N bridge is useful in combatting this as it combines a vintage-spec 2 7/32" screw spacing with modern 2 1/16" string spacing. It's a drop-in replacement for vintage-spec Strats, and it cures slippage by moving the E strings further towards the centre of the fingerboard. Bent steel saddles and a cold rolled steel block come as part of the package, and the narrower spacing might also be a better match for Strats with humbuckers.

Callaham make very high-end hardware and this Vintage/Narrow bridge has modern string spacing with vintage-style pivot screw spacing to prevent E strings from slipping off the fingerboard.

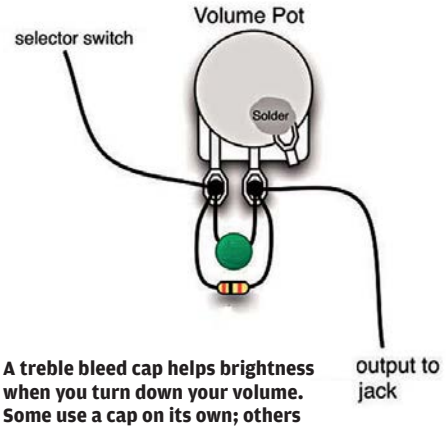
23 TIGHTENING THE NECK JOINT

If a guitar's neck is loose in its pocket, then it will be less effective at transferring vibrations. On top of that, the neck may actually move around, causing tuning instability and string slippage. On occasion you can see a gap between the bottom of the neck and the neck pocket, even when the screws are fully tightened. Assuming there's no shim, this could be because the screw holes in the body are too narrow for the screws. If you can't push the plate screws straight through the body holes, you should have them drilled out to increase their diameter. Many builders experience this issue with replacement bodies.

If your Strat's neck screws appear to be fully tightened but there's still a gap visible between the body and the neck, it requires some attention. Assuming there's no shim, there should be no gap whatsoever.

24 TREBLE BLEED

Does your tone get dull when you turn down? If so, try soldering a capacitor between the input and output terminals of the volume pot. When the volume control is fully up, the cap is bypassed, but when you turn down, the cap allows some of the high frequency content to bypass the volume pot and go straight through to the output. Suitable capacitor types include ceramic disc, film and silver mica. Be careful, as if the capacitor value is too high, you may experience some excessive brightness as you back off. Some suggest a 130K resistor in series with the cap to reduce the treble bleed or a 100K resistor in parallel with the cap to modify the pot taper. Begin with a 1000pF, and be prepared to experiment.



A treble bleed cap helps brightness when you turn down your volume. Some use a cap on its own; others prefer a resistor in series or – as shown here – in parallel with the cap.

25 TUNE YOUR TREM

Leo Fender and his team intended the Strat vibrato to be a floating unit, where the spring tension balances out the pull from the strings. There are no hard and fast rules about setting these up, because all players require different feels. Some require no upward movement, but most prefer to be able to vibrato above and below pitch. Tightening and loosening the claw screws fine-tunes the trem response, and it can be done with surprising precision. Carl Verhayen tunes his trems so the G, B and E strings pull up a minor third, a tone and a semitone respectively. It sounds very musical and it's surprisingly easy to set up.

This spring claw is intentionally angled because it has been adjusted to provide precise intervals when the bar is pulled up.

FRETBOARD WORKSHOP

KEEP IT CLEAN

Are you suffering from gunk? We lift the lid on one of the shameful secrets of the guitar world, fingerboard hygiene.

Take a look at the fingerboard on your guitar. Can you see a row of six elliptical mounds of grime between the frets? Tish, you ought to be ashamed of yourself. What on earth produced this muck? Well, you, basically. No matter how clean you think your hands are, grease and sweat from those digits will eventually be compressed onto your fingerboard. Of course there can be more contributing factors, namely beer, nicotine, sandwiches....

The resultant effects of dirty strings are all too familiar: dull notes, poor intonation and that general 'my-strings-are-cheesewire' feeling. But before abandoning your playing to set up as a free cutting service for Monsieur Camembert's Cave du Fromage, take heart: this can be avoided (or at least reduced). Set aside a one-off hour-long session to clean your fingerboard, and get into the habit of preventative measures.

But first things first. Remove all the strings and throw them away. On guitars with fulcrum vibratos (Fender vintage, unrecessed Floyd Rose, Wilkinson, etc) place some thick card, a few business cards or plastic credit cards (expired only), or the vibrato's backplate under the back of the vibrato – this will stop it being pulled back by the springs when you remove the strings.

The fingerboard

The most common types of timbers used for fingerboards are rosewood, maple and ebony 1. The rosewood and ebony boards are usually 'unfinished' (although a light oil can be applied for some moisture protection and to enhance the condition of the wood) while maple is typically more heavily protected by a clear or tinted finish.

Finished fingerboards

There are different methods of cleaning the different types, so let's start with the finished fingerboard, which is usually made of maple. You may have read articles or books encouraging you to use soap and water to clean the grime which collects between frets. I've witnessed the effects of water on wood and modern finishes – it's not advised. White spirit applied with a soft rag is much safer, as it dissolves grease and softens dirt with no danger of damaging the fingerboard or finish. Ball up the cloth into a small pad and dip it into the white spirit. Using small circular motions, you should find that all the dirt lifts straight off the lacquer. The most difficult area to clean will be on the very edges of the frets. A cocktail stick with a piece of cloth on the end will get into the tightest of corners.

There's a good chance that, if the fingerboard is dirty, the frets will be tarnished. You can kill two birds with one stone at this point, as both the frets and the fingerboard can be polished in one hit, with Brasso. This product is not like other liquid abrasives; its cutting abilities are aided by ammonia, which makes it perfect for polishing metals and modern plastic finishes. Apply the Brasso onto a soft cloth and rub the entire top surface of the fingerboard – in line with the frets, not along the length of the neck. Obviously, the harder you rub, the shinier your frets will be. Always finish off with a quick wipe from a clean cloth. When you are satisfied, restring and set up the instrument.

Unfinished fingerboards

Working on these is a little more involved. To achieve that 'factory look' on your frets and fingerboard, you may need to go shopping first. You'll need...

Masking tape (insulation tape is not the same thing)

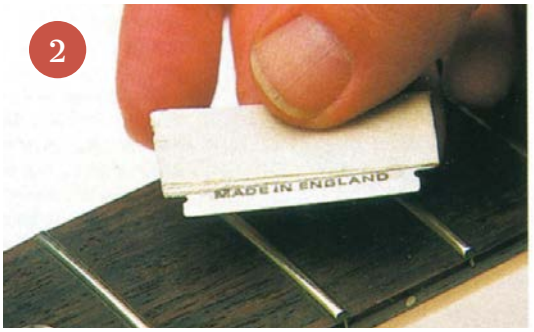
600 and 1200 grit wet and dry paper

A straight razor blade (double or single-edged type)

0000 wire wool (that's very fine)

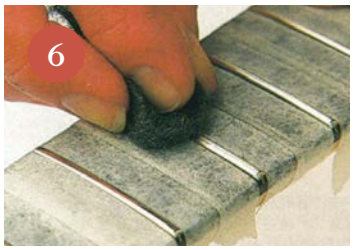
A small bottle of fingerboard oil

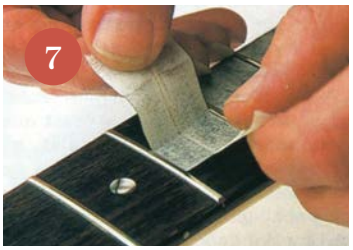
With the exception of the oil, you'll get all of this at a high-street auto store. Single-edged backed razor bladesshould be available from an automotive paint supplier. If you can't get those, standard double-edged blades are fine, although you must wrap sufficient masking tape around one edge 2. This is not only a safety precaution: it allows you to identify the edge that was last used. The double-edged blade will feel more flexible and may well be more suitable for beginners trying this method for



1 Rosewood (top) and maple fingerboards

2 Tape that razor blade very carefully





3 Using the blade to scrape the face of the fingerboard

4 Taping up the board with masking tape

5 Polishing frets with wet and dry

6 Final polish with 0000 steel wool

7 Remove the masking tape from the ends inwards

8 Final buffing with fingerboard oil

the first time. As to the fingerboard oil, we recommend Manson's Fingerboard Oil, a lemon oil-based preparation which works very well, and the small bottle will last a very, very long time. Alternately look for almond oil (in the ingredients section of your supermarket).

On this type of fingerboard, you should take the precaution of taping up the areas of the guitar which could be marked in some way. The headstock, pickups, and the portion of the body around the neck joint are favourite targets for over-enthusiastic polishing.

Now take the razor blade in hand; the idea is to use it as a miniature scraper. But first, a word of warning: some guitar manufacturers would have you believe that your fingerboard really is either rosewood or ebony. Imagine that sinking feeling as you scrape off a top layer of coloured dye to reveal a very much lighter coloured wood underneath. If you're not sure whether your board is pukka, always get a second opinion. Alternatively, scrape a little right behind the highest fret, rather than anywhere more important, to see if the colour changes dramatically.

Take the blade between the thumb and forefinger of both hands **3**, and hold it at roughly 80 degrees to the fingerboard surface. Remember, as you scrape back and forth between the frets (with the grain), you are merely trying to remove the dirt from the fingerboard. It doesn't take a genius to realise that there is a risk of scalloping the board if you press too hard. I'll repeat that: think about what you are doing. Don't worry if the fingerboard has any inlays of pearl or some other material. So long as the blade is sharp, it will deal with them.

By now, you may be horrified at what you've just done. Don't panic. All those wood 'shavings' will soon be a vague memory. Take the OOOO wire wool and rub furiously along the length of the fingerboard, frets included. I know what you're thinking, trust me.

At this point, the wire wool will have cleaned away any debris which may have been compacted along the length of the frets. You will also be aware that the frets now have a matte finish, thanks to tens of thousands of tiny scratches.

Wipe the board down with a clean cloth. It will make you feel better. Take the masking tape and, very carefully, mask the fingerboard **4** so that only the frets are showing. This will mean that once you get as far as the 8th or 9th fret, you will have to start cutting the tape in half in order to keep things neat.

Using an old pair of scissors, or the edge of a work surface, cut two or three 50mm squares of 600 grit wet and dry paper **5**. This will be plenty. Wrap the square around your finger and rub along the length of each and every fret. Only move onto the next fret when all of the scratches left by the wire wool have disappeared.

Fingers sore? I have news for you. Do exactly the same thing now with the 1200 wet and dry. Don't skimp. If you have knowingly left scratches, you will feel them later when you bend strings.

Now it's time to get the wire wool out again. The fine OOOO grade will remove any traces of the 1200 grit wet and dry paper, and will leave the frets looking like chrome **6**, and you will probably feel quite pleased with yourself. It's crucial, however, that you don't get too carried away. The next part, although extremely straightforward, needs patience.

The masking tape must now be removed **7**, but you have to lift the two ends towards the centre. This method prevents the lacquer on the edge of the fingerboard from chipping off.

The worst is now over. Wash your hands and find a clean, soft cloth. Put a few drops of the fingerboard oil onto the cloth **8**, and wipe well into the grain of the fingerboard. Turn the cloth over and buff the whole neck. It's vital to remove the excess oil as, although it protects the fingerboard, it can actually cause the strings to deteriorate. Wait half an hour or so for the area to dry, give it a final buff with an oil-free cloth, and re-string.

Follow these instructions and chances are that you'll have a neck that's better now than it was when the guitar was made, as most manufacturers cannot afford the time for such luxuries. So what can you do to keep it looking that way? Keep a small towel or cloth in your case or gigbag so that you can give your hands a wipe before, and the strings a wipe after you've played. Fastfret and other cleaning and lubrication products are fine – but keep it clean in the first place and you'll find your strings last longer. Keep it clean, and clean it often... you know it makes sense.

The guitar as it was before we started and right - the finished article

DIY WORKSHOP

REFINISHING YOUR GUITAR

This 1990 Japanese-made Ibanez RG550, originally metallic red, was badly damaged in a bizarre plumbing incident. What better subject for a complete transformation? **HUW PRICE** rolls up his sleeves and gets to work

After this Ibanez was water-damaged the owner chose to cover the body with sticky transfer sheets, but they crinkled up badly under the clear lacquer top coats. We decided on a complete make-over, adding a bookmatched maple veneer top with a trans black finish to restore this shredder to its former glory..

STAGE 1
Stripping the body

The guitar's owner, Roger, had already done most of the work when he used a heat gun to remove the original poly for the first refinish. We peeled off the transfer and hit the white paint with stripper, but since the plan was to add a veneer and we needed a clean gluing surface, we put the whole body through the flat sander at our local woodworking shop. On the back, we took off just enough to get rid of the paint; the top lost 1.5mm to compensate for the thickness of the veneer. This left a sharp line where the chamfer met the top surface 2, a problem when it comes to folding a veneer, so we used a plane followed by a sanding block to reinstate the curve 3.

STAGE 2
Preparing the top veneer

David Dyke (www.luthierssupplies.co.uk) came up trumps with the bookmatched veneer they sent for the body – and at 3mm thick it was about the same as an acoustic guitar top. We had to join the two pieces together. They were placed on top of each other, edges closely aligned, then clamped to a shooting board (you can make a shooting board from two pieces of MDF; see 4. A block plane will remove wafer-thin shavings from both edges simultaneously until both are straight and true. To test the joint, place the edges together, hold them against a window pane, and look for any daylight. This is called 'candling'. Keep working with plane and shooting board until not a speck of daylight shows through.

You don't need any specialist tools to glue the veneer halves together – just a flat board, some small nails and some heavy weights. Place the pieces with joint edges together and something under each end to hold the joint a few centimetres above the board – like a shallow 'roof'. Draw along the outer edges with a pencil, remove the veneer pieces, then hammer in a nail every few centimetres along the outside pencil lines. Place the two pieces back on the board with the outside edges butted up against the nails, and apply wood glue all along one edge. Press the centre edges flat against the board, allowing the nails to push the joint together. Place a long, flat piece of wood all along the joint, and put heavy weights on top. Make sure you apply plastic packing tape to the backing board and the piece of wood supporting the weights; some glue will squeeze-out, but wood glue won't stick to plastic 5.

On a flat-bodied guitar the 3mm-thick veneer would have been fine, but it's too thick to bend around the body chamfer, so it was back to the woodworking shop to sand it down to 1.2mm.

STAGE 3
Veneering the top

Obviously our join had to run up the centre line of the guitar, but we have options regarding which areas of grain to use. You can cut the body shape out of a piece of paper and place it over the veneer to help visualise the end result, then draw around the cutout to mark the shape of the body 6. Now cut out the body shape with a craft knife, leaving 5mm around the edge for safety. This allows you to get your clamps close to the edge of the body, and cuts down on trimming later.

When gluing veneers it's important to spread the pressure across the entire surface, so I cut two clamping cauls out of scrap plywood, just a bit larger than the body. This makes clamping much easier and protects the body from the clamps. For the top chamfer, we cut the veneer diagonally across the starting point of the chamfer curve then held it down with gaffer tape (masking tape isn't grippy enough for the job). Using gaffer tape is a bit risky, but no grain was lifted 7.

For gluing the veneer, we decided not to use Titebond, >

1 The clear gloss top coat made the sticky backed plastic crinkle up. Action is needed!

2 Body preparation: the thickness sander left a rather sharp line along the body chamfer

3 The chamfer edge was smoothed over to allow the veneer to bend over it nicely

4 Shooting board: two lengths of MDF stuck on top of another to create a 'step'

5 The veneer halves are glued on a clamping board. Note nails on the outside edges

6 Using a paper template helped us decide which section of the veneer to use

which hasn't always been too successful for us on this kind of job in the past, but Humbrol Cascamite – actually urea formaldehyde glue, just like the stuff Gibson used to attach maple tops on Les Paul bodies in the '50s. This comes in powder form which is mixed with water, and unlike Titebond, it doesn't go off too quickly.

STAGE 4
Trimming the veneer

A pro luthier might use a router to trim the edges of the veneer, but in our workshop articles we like to use non-specialist tools. It'll take you a while to trim the body edges and the pickup and bridge routs using a craft knife, but it's quite possible. Make sure you've got plenty of fresh blades, and watch those fingers! Next, use a sanding block to true up the sides and round over the edges of the body and the routs.

To reinstate the holes for the knobs and switch, place the body face-down on a piece of plywood and drill through the centre of each hole with your thinnest drill bit. Use the original holes in the control cavity to guide you, then flip the body over and use these pilot holes for larger bradawl bits. I was able to drill the switch screw holes to size straight off, but had to use a reamer to widen the holes for the pot shafts to the correct diameter. For the switch slot I drilled undersized holes all the way along its length then cut out the wood between the holes with a craft knife, then used a small file to true up the edges of the slot 8.

STAGE 5
Veneering the headstock

A matching maple headstock veneer would give this guitar a real touch of class; sadly the old refinish had left the front surface uneven and rounded towards the edges. Rather than use paint stripper, we began to sand off the gloss black using a flat sanding block. As the wood started to show it was easy to see the low spots 9, so the sanding continued until the black had almost disappeared. This reduced the depth of the ledge that the locking nut sits on, but that depth will return when the veneer is applied 10.

David Dyke provided a nice piece of maple veneer and once again we placed a cutout template over it to find the area of grain that worked best for the shape. Again, it's best to draw the outline onto the veneer and cut out the shape leaving 5mm extra all around the edge.

Next we made two clamping cauls, roughly the same shape as the headstock, from a scrap piece of plywood. Our headstock wasn't quite flat, so I stuck a piece of cork tile to the underside of the top caul using double-sided carpet tape, hoping that this softer material combined with clamping pressure would conform to any curves.

With Cascamite glue applied, the cauls were positioned and the G clamps tightened 11. The headstock was left overnight, and when the clamps came off the result was just about perfect. The next task was to carefully true up the edges using a craft knife and a sanding block, then re-establish the locking nut ledge using a mini sanding block made from a wood offcut 12.

Remember the paper template we made for the headstock? Before I applied the veneer I used the cutout section to record the position of the trussrod rout and the screw holes for the trussrod cover and string tree. Guided by the template marks I drilled through the veneer to reinstate the holes, then carved away the maple covering the trussrod rout. From the rear I drilled pilot holes through the centre of each tuner hole, enlarged the holes in the veneer with a wider bradawl bit, then used a reamer to increase them to the right size. After flat sanding with 240 grit paper, the head and body were ready for finishing 13.

STAGE 6
The trans black finish

Because of our cool-looking veneer, we opted for a PRS style 'stonewash' finish. On the figured maple tops that you see on guitars by PRS and Suhr and so forth, the maple is dyed before the finish is applied. This makes the grain 'pop out' regardless of the viewing angle.

For our water-based black stain we settled on a 3:1 ratio of dye to water. First, raise the grain of the

7 Clamping cauls for front and back protect the body and distribute the pressure

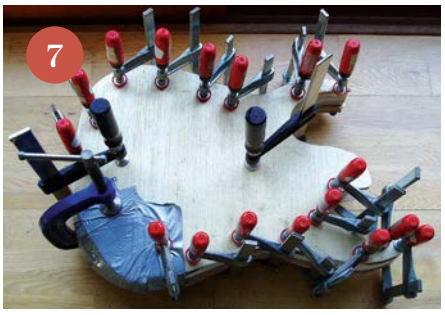
8 The edges and routs were trimmed flush using a craft knife and sanding blocks

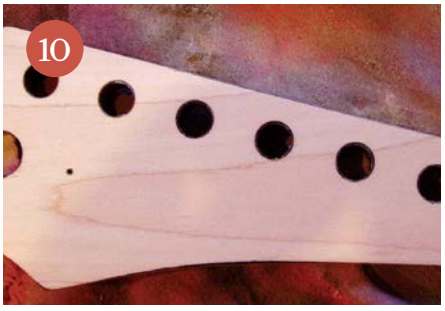
9 Sanding the finish off the front of the head. The black areas reveal the low spots

10 The work has paid off, and our Ibanez's headstock is now ready for veneering

11 The headstock veneer is glued in place. Too many clamps is just about enough!

12 Here's the headstock veneer glued in place and dry and ready for edge trimming





veneer by wiping it over with a damp cloth; when it's dry, wipe on the dye. At first our guitar looked dark purple, but after sanding off most of the dye it got a lot better. If you repeat the dying, sanding and wiping process, it accentuates the contrast in the grain 14-19.

STAGE 7
Spraying

Steve Robinson (www.manchesterguitartech.co.uk) supplied two cans of black gloss and two of clear gloss nitrocellulose. The maple top was first protected with a few coats of clear gloss. Once dry, I masked off the front of the body and sprayed satin black into the bridge and pickup routs. Next I brushed high-density cellulose base coat from Fiddes (www.fiddes.co.uk) onto the back and sides and sanded everything smooth. The mask for the front was secured loosely; firmly fixed masking tape leaves sharp edges in the lacquer when it's peeled off. I then placed the body face down on two risers to spray the back and sides black.

We decided on a thin black burst around the edges to 'blend' in the veneer top. After removing the front mask and laying the body on its back, we carefully sprayed the burst, holding the spray can over the centre of the body and directing the spray outwards. Start by spraying beyond the edge then gradually bring it towards the body until you see the edges of the body picking up the colour. Be patient and build up the burst slowly. If you end up with splutters or overspray, you can sand off the excess because there are clear coats underneath.

Next I covered the whole guitar with several coats of clear gloss and set the guitar aside for a week. The finish was then cut back using 800, 1200 and 1500 grit wet and dry abrasive paper in the usual way. After buffing to a deep gloss with Farecla G3 and 3M Machine Polish and sticking an Ibanez logo from eBay on the headstock, the guitar was ready for reassembly 20.

Verdict

For a project like this, remember that you don't have to use black dye – the procedure would be the same if you wanted your guitar to be trans blue, trans red or trans-anything. It involved quite a lot of work, but we're delighted with the results. You can still find Ibanez RGs like this for less than £300 second-hand, and with some time and around £100 in materials you could end up with a superb maple-topped guitar. What are you waiting for?

13 The headstock veneer, trimmed, with tuner holes reinstated and truss rod nut exposed

14 Our body after the first application of stain. At this stage it looks a bit purple

15 Here's the body with the first coat of stain sanded back. Not too handsome, you say?

16 When the veneer is wiped down with white spirit, it really starts to look exciting

17 More staining. We're adding a second application to get the colour to go darker

18 Stain sanded back again. More stages give more grain contrast but less 'movement'

19 A second wipe down with white spirit gives an idea of how the guitar might look

20 With black burst and clear coats added the Ibanez is transformed

LAP STEEL PROJECT

LAP OF LUXURY

Many guitarists are tempted by the lap steel but most don't own one, so why not build one yourself? It's the perfect project for a budding luthier, and **HUW PRICE** can tell you exactly how it's done

If you have ever fancied having a stab at guitar building, a lap steel is a brilliant place to start. There's no awkward truss rod installation, no tricky neck carving and, best of all, you don't even need frets. This month, we're going to try to create our very own lap steel guitar in a single weekend..

Starting out

First we need the wood for the body. Ever since I moved into my house, I'd been eyeing up the wooden mantelpiece 1, Brian May-fashion, but with a view to making a lap steel. The wood actually turned out to be African mahogany, or Khaya Ivorensis, to give it its posh name.

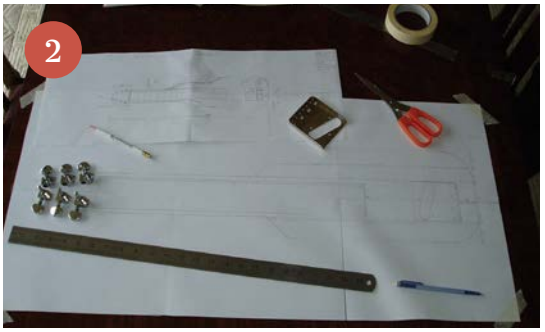
Next, the fingerboard. I checked in the Stew-Mac catalogue and noticed that they sell flat, pre-slotted Dobro fingerboards in ebony and rosewood, 19" long and 2 3/8" wide with a scale length of 25". Since I didn't want to get into the tricky business of fret slotting, I designed my project around this board.

I didn't really want to recreate a classic design, so instead I looked at loads of lap steels on the internet then made a sketch of my own. Next, I had to draw up scale plans. When I'm building guitars I prefer to work with Imperial measurements because the US parts suppliers do the same. When creating scale plans, I simply make 1cm equivalent to 1", so the 25" scale length became 25cm. Once I was happy with the shape and dimensions, I taped together six sheets of A4 paper and drew up the full-scale plans. This is worthwhile because it reveals errors, and you can even physically arrange parts on the drawing, like tuners, 2 to make sure that everything fits.

Since I don't have any specialist timber-cutting equipment, I took my plank up to my local joinery firm and they cut it into three strips – 3" wide for the centre block and 1" and 1 1/2" strips for the wings. They also planed the front and back surfaces so I had everything smooth and squared up. At home I sawed the wing strips to length, cut the angles using a mitre saw, and marked out the centre block.

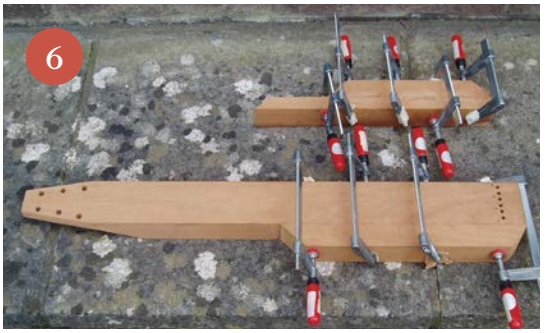
In the workshop

Once the centre block was cut to length I drilled the machinehead holes to avoid any chipping-out, then made a straight cut using the mitre saw where the neck taper meets the base of the peghead 3. After this I removed the unwanted timber using a chisel and smoothed everything out using a Carroll drum sander attached to my electric drill, held tight in my drill press 4. Drill presses for conventional hand drills are cheaply available in most DIY stores, and you should be able to get a Carroll drum sander in any specialist tool shop. Be careful



1 Our lap steel in its original 'fireplace' form

2 Making full-scale plans is a good idea



3 Here are the main body parts, all ready

4 Fine-shaping with a Carrol drum sander

5 Remember to drill a hole for the pickup wire

6 First stage of gluing the body together

not to apply too much pressure – especially if, like me, you only have a cheap drill press – because the Carroll won't sand straight. Also make sure you wear a breathing mask and a pair of goggles. That exotic sawdust can be irritating.

I had decided to fit a T-style bridge, partly because I happened to have a spare one already along with a load of T-style pickups. The other good thing about this kind of bridge was that I knew I could buy a bridge cover if I needed a hand rest. After I had drilled the string and screw holes for the bridge, I clamped one of the wings onto the centre block and drilled a through-hole to get the pickup wire into the control cavity 5.

I drew the curves of the lower bout onto the wings and knocked off the corners with the mitre saw. The plan was to round them off later with the Carroll sander (most pros would probably do this with a bandsaw, but I don't have one). Next I brushed on some Titebond glue and clamped the body parts together 6. Besides drawing up the plans, I'd estimate that all the work so far had taken me less than five hours. After sitting overnight the clamps were removed, and Day Two began.

Gluing and Routing

I had chosen to use a T-bass style control plate, so I needed to make the holes for the controls and the pickup. After carefully marking everything out, I drilled the output jack hole using a 1" bit and then chain-drilled all around the areas where I needed to remove wood with an 8mm bradawl point bit. For this the drill was mounted in my drill press so each hole ended up exactly the same depth.

I removed the excess wood with a Dremel-type tool and a router bit in a Stewart-MacDonald mini-router base. Serious routing with a Dremel is tricky, and you should work your way slowly to the required depth otherwise the router bit will be torn loose or start wandering around all over the place. If you haven't got a router, you could clean out the holes using a chisel. The results probably won't be as neat, but nobody's ever going to see it 7.

Now the body was ready for final filling, shaping and sanding. It's worth taking your time over this phase because the quality of the finish depends on the preparation. My timber had been fixed to the concrete fireplace with a number of large nails, so I had to fill all the holes using wood filler. I used the stuff that comes with a separate hardener, just like car filler. Once that was dry I sanded everything smooth, masked off the area where the fingerboard was to be glued on, and brushed on a coat of shellac-based sanding sealer.

Since I was aiming for a faded TV yellow finish I misted on a covering coat of the nearest colour I could find in Halfords – Rover Primula Yellow 8. Once that had dried I applied some dark grain-filler and followed this with some more misting colour coats. With just a hint of grain showing through the finish, I applied several coats of clear cellulose lacquer. The one I always use is Fiddes Bone Hard (www.fiddes.co.uk), which is available in aerosols. The finish had to sit for a week or so to harden before I could polish it up. I cut the surface back with 1500-grit wet and dry sandpaper (used wet) and then polished it, first with 3M Machine Polish, then Farecla G3. I used to use T-Cut but the ammonia in this product softens the finish, making the polishing stage much harder.

Painting

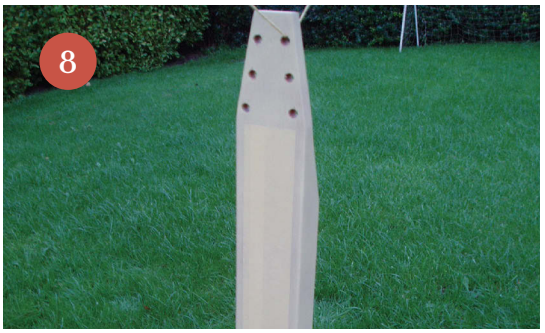
Next it was time to move onto the fingerboard. I drilled the holes for the position markers using an 8mm bradawl bit before I glued on the fingerboard because I didn't want to risk damaging the finish in the drill press. Next I removed the masking tape from the body and dry-clamped the fingerboard into position. I drilled two small pilot holes through the board and into the body for locating pins when the board was being glued on (I know from experience that things can slide about once that slippery glue is applied). I unclamped the board, tapped a couple of panel pins >

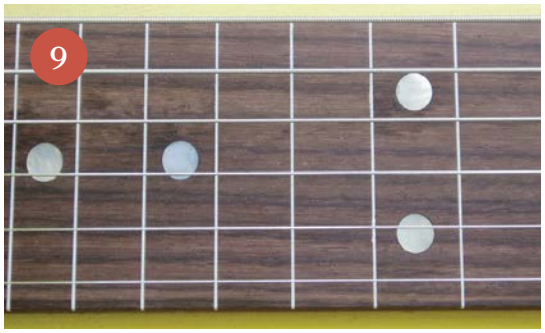
7 Body routs done: note the output jack hole

8 First coats. Note masked fingerboard area

9 White 'fret' strips and pearl dots installed

10 L-section nut cut and screwed into position





through the pilot holes, and applied Titebond glue to the bottom of the fingerboard. After carefully lining up the panel pins with the pilot holes in the body, I tapped them in a bit and clamped everything down to glue overnight.

After removing the panel pins, I glued in the pearl dots 9. Installing frets on a brand-new fretboard is actually much easier than you'd imagine but there's not much point when you're building a lap steel: the 'frets' are merely visual markers, so I used 0.02" white binding strips instead. The fingerboard slots were 0.023" so the binding just tapped in, and it was such a tight fit I didn't even need glue. The whole procedure took just a few minutes, and I sanded everything flush using a sanding block. It's best to fit the 'frets' with the fingerboard already installed because if you tap them in beforehand they will cause the fingerboard to curve, and this will make it harder to glue down.

Finishing off

I flipped over the body and tapped the string ferrules into place using a hammer and a length of dowel rod to protect the body. After attaching a Shed Spider pickup to the bridge, it was simply a case of threading the wires through that pre-drilled hole into the control cavity and screwing down the bridge using the pre-drilled holes. I attached the pots to the control plate and wired in the capacitors, then joined the pickup wires direct to the volume pot. The output wires were soldered to a regular mono jack socket that was bolted to a curved plate and screwed in place onto the body.

The next stage was to fit the tuners. I ended up using some Schallers that were sitting in my parts drawer.

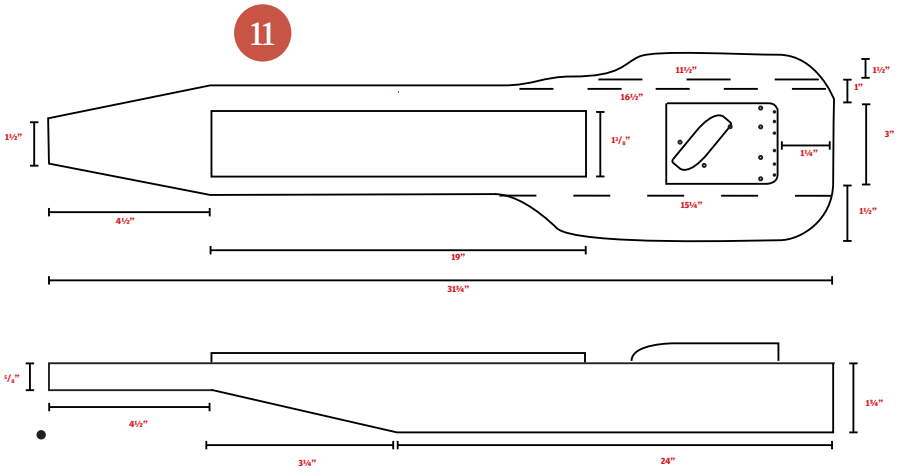
Making the nut was really simple. I bought a length of 1cm x 2cm 'aluminium corner' from B&Q, cut a piece to the width of the fretboard, then drilled three holes in the 1cm side and screwed it onto the headstock 10. I measured to make sure that each bridge saddle was exactly 25" away from the nut, and loosely attached the strings. I stuck some masking tape over the top of the nut, spaced out the strings by eye, marked the top of the nut on each side of every string and cut the slots using nut files. If you haven't got nut files, you can get by with a needle file and some abrasive paper.

Conclusion

To be honest, this project took me more than one weekend, but that's only because I decided on a sprayed finish to make it look as good as possible. You could make this project even simpler by applying an oil finish or just waxing the wood.

So is this the 'lap of luxury'? Well, to me it sounds just like lap steels sound on records. It sustains for days and, more by luck than planning, that volume control is perfectly situated for volume swells. All I have to do now is buy some heavier strings for those countrified 6th tunings, and then figure out how to play it. Wish me luck!

11 Example Blueprints for making your lapsteel



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DIY WORKSHOP

ACTION STATIONS

Adjusting a guitar's action is a matter of understanding and balancing several interacting factors. **HUW PRICE** explains all

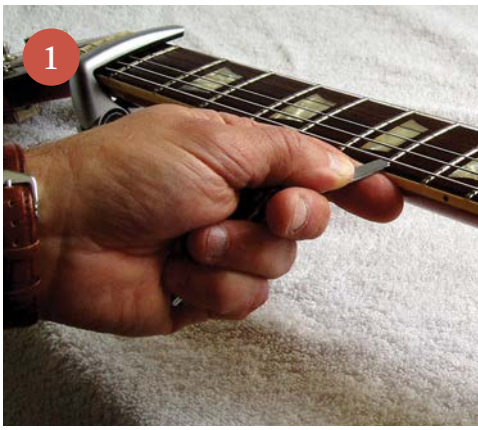
Life is full of commonly used words and phrases that we only partly understand. We may use them from time to time, but if pushed we'd struggle to provide accurate definitions. In politics and we have 'budget deficit'; in sound engineering there's 'impedance'; while in the world of guitars there's that little word 'action'..

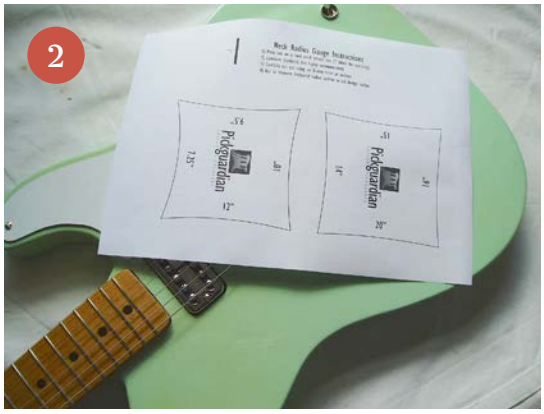
Action means different things to different people, but at a very basic level it's generally attributed to string height – i.e. the gap between the top of the frets and the guitar strings. Those with a more rounded understanding may use 'action' as a catch-all term to cover the overall playing feel and setup of a guitar.

Many of us will have shaken our heads in disbelief when reading forum posts describing how someone has bought and sold several examples of a particular guitar because the action was always lousy. This beggars belief... because action can always be adjusted. However, there are various technical issues and build quirks that may prevent your guitar from playing properly with your preferred string action. So let's take a look at the other factors that dictate how a guitar can and should be set up, and discover what we can do to achieve the best action possible.

The highs and lows

Received wisdom usually states that a low string action is good and a high string action is bad. Those who are old enough to remember cutting their teeth (and fingers) on cheap Far Eastern guitars with strings half an inch or so off the fretboard will recall that upgrading to better budget guitars or eventually a real Fender or Gibson





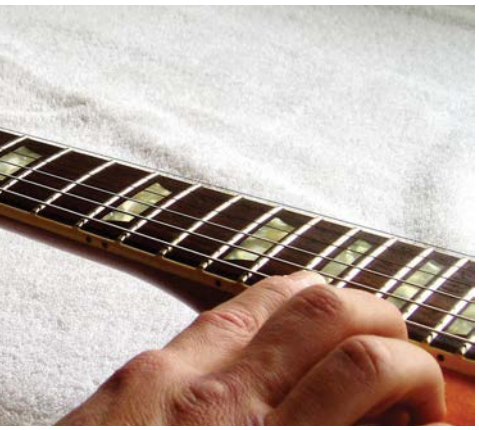
1 Checking the neck relief with feeler gauges, with a capo at the first fret and a finger at the fret nearest the neck/body join

2 Download some radius templates free from the web, print them off and cut them out carefully with some very sharp scissors

3 If you're having a re-fret, it would be a good time to have a chat with your luthier about fingerboard radius as well as fret size and height

brought ever-improving playability. These days we can expect even the most affordable guitars to be perfectly playable, so the action-to-price equation no longer applies. If you can now set things any way you want it, what are the pros and cons of high and low string action?

String height will affect your tone. You'll probably find that higher action produces a fatter sound with more sustain, while lowering the action makes the sound thinner and less resonant. So balancing tone with playability can be a bit of a trade-off, but the extent to which this is noticeable will depend on the way you use your amp and effects. High gain can cover a multitude of sins.

Your playing style may also dictate how your guitar should be set up. At one extreme we have guitars that are set up exclusively for slide; the strings need to offer some resistance to the slide and you'll want to avoid having the strings touching the frets at all, so heavier strings and a medium or high string action with shallow nut slots is the way to go. At the other extreme, guitarists who play metal or fusion or just like to shred will need lower action to perform lightning-fast runs, hammer-ons and pull-offs. A flatter fingerboard radius is also preferable for string-bending too.

Fingerboard radius

When starting out, I was always told that Gibsons had lower action than Fenders. Prior to the 1980s this was generally true – but, to be more accurate, Gibsons had the potential be set up with lower string action. This was because Gibson's preferred fingerboard radius was 12" compared to Fender's 7.25" (modern Fenders tend to have a 9.5" radius).

Fender's vintage fingerboard radius can cause problems if the string action is set too low. As you bend a high E or B string, the string height stays the same but the fret height becomes relatively higher due to the curve of the fingerboard. Consequently the vibrating string comes into contact with the higher frets as it is bent, which causes buzzing, reduces sustain and eventually chokes out the string.

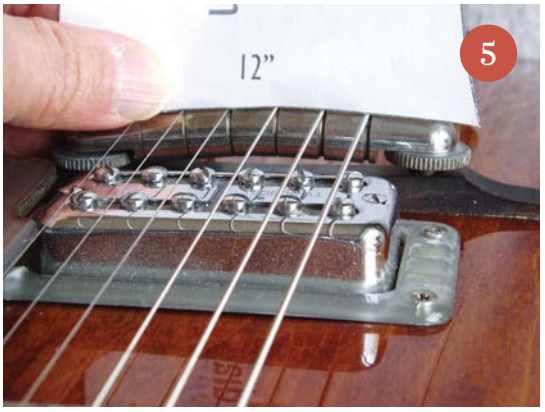
The only easy solution is to increase the height of the string to the point where it can be bent without coming into contact with the frets. This is true for most guitars, so it follows that a flatter radius board allows the strings to be set lower – and that's why shredder guitars from the likes of Jackson and Ibanez have boards with radii closer to 16".

If you do a lot of chord work (particularly barre chords) and little lead playing, a Fender-style radius will probably make your guitar more comfortable to play. Some makers offer necks with a 'compound radius', with a fingerboard surface like a section of a cone, more curved at the nut end and gradually becoming flatter up the neck, thus offering the best of both worlds. Apparently lots of vintage guitars, particularly Fenders, have ended up with compound radius necks, as this often occurred during re-fretting when the fingerboard was sanded to remove dents. It may not be vintage-correct but it can make for a more playable guitar.

It's a relief

Consider for a moment the arc of a vibrating string. The displacement from centre is greatest halfway along the length of the string, and displacement is lowest near the nut and bridge. Consequently, if the fingerboard is perfectly flat along its length – or worse, bowed backwards – a low-set string won't have enough space to vibrate without buzzing against the frets. It's thus common practice to set up guitars with a small amount of neck relief, with the trussrod slackened off to allow the string tension to bow the neck very slightly forward. You can check neck relief visually by placing a finger or capo on the strings at the first fret and pressing the low E string flat against the frets where the neck joins the body. You should notice a very slight gap between the top of the seventh fret and the string if the neck has some relief.

If you're experiencing fret buzz around the lower and middle frets, the chances are that the neck has no relief or a back bow. Raising string action may cure the buzz, but your guitar will become harder to play. The only workable solution is to slacken the guitar's trussrod to create some relief. How much relief is a matter for debate, but >

4 Cutting nut slots to the ideal height takes experience and an expensive set of nut files. It's really a job for the professionals

5 This Gretsch has a solid bar bridge, but you can use a radius gauge to check it's the right match for your fingerboard radius

gaps up to around 0.02" are typical. You can measure neck relief using the type of feeler gauge available in car accessory shops. However, you may prefer the feel of a flat neck.

The real key to action set up is to realise that everything has a knock-on effect on everything else. If you slacken the trussrod too much and the neck ends up with too much relief, the action will feel higher. If you lower the saddle to compensate, your guitar may play fine at the lower frets, but may buzz higher up the fretboard. You have to play the guitar to determine if it feels good and hone in on the optimum setup.

Wood moves about depending on temperature and humidity. This will cause the neck relief to increase and decrease. Your neck is far more likely to move than the saddles on the bridge. If the intonation on your guitar goes off, you should check the neck relief before adjusting the saddles. If the back bow has increased, the scale length will have increased – and vice versa for a forward bow. Learning how to adjust a trussrod is everyone should do. Read up about it, confine your efforts to a quarter-turn, and always use the correct tool. You'll discover that you are able to keep your guitar in optimum playing condition.

Fret height and wear

Frets, like car tyres, eventually need changing, but frets don't always wear evenly because we tend to stick to certain keys and therefore wear occurs in localised areas. This explains why certain notes induce fret buzz while others play cleanly. Again, raising string action can reduce buzzing but compromises playability. For a low, buzz-free action, your frets need to be level. Fretwork isn't daunting: it's just maintenance. Most likely the frets will simply need a light stoning to get them level, followed by dressing to restore the crowns, and a polish. While older or heavily-used guitars may need their frets replacing, guitars can remain playable with very low frets, but string-benders will miss the fret height that allows your fingers to get under the strings for more secure grip, easier bends and better vibrato control. The bottom line: fret health is crucial to achieving a nice playing action.

Nut business

String height can be adjusted at both ends, and the depth of the nut slots has a big influence on playing feel. Cutting the slots to the optimum depth is a skilled job that requires time and care – hardly compatible with mass-producing guitars. Many factories cut nut slots cut on the shallow side because it saves time and money.

When you get that new guitar home, the chances are that the nut will need some attention before it will play its best. If the nut slots are too shallow you may find it harder to hold down notes at the first fret regardless of the saddle height, and open chords might feel a bit stiff, or may even sound out of tune. If the slots are too low you'll hear fret buzz as the open string vibrates against the first fret.

Saddling up

Although setting the saddle height may have seemed like the logical first stage in adjusting the action, we've left it until last as there's far more to 'action' than simply raising and lowering the strings. Hopefully we've identified the factors that may thwart your attempts to lower your action and explained why you may wish to try setting your string action that little bit higher.

The limit on how low you can take the action will be pretty obvious when choked out bends, buzzing and lack of sustain impact too much on tone and playability. After setting the neck relief, try taking the high string down to where it's low enough to fret easily but high enough for decent tone and easy bending.

Since the fingerboard is curved it follows that all the strings cannot be set to the same height. The outside strings would be way too high if the middle strings were set at a workable height, and if the strings were lowered to make the outer strings playable the middle strings would be touching the frets. Ideally the string heights will be set to follow the curve of the fingerboard.

Tune-o-matic and wrapover bridges do not allow you to adjust the height of individual strings. Tune-o-matic saddles sit at differing heights to achieve the required curve and the radius is cast into wrapover bridges. Fender-style bridges allow for individual string height adjustment. Many luthiers use radius gauges to set the saddle radius accurately. You can download printable gauges; just Google 'guitar radius gauge' and go from there.

Since the strings are set above the fretboard the string radius should perhaps be slightly larger than the board radius, but setting them identically seems to work fine. If you're unsure of your fingerboard radius you can use the downloaded gauges to determine what it is. Guitars set up this way tend to play very evenly and the strings always seem to fall where your fingers expect them to be. It does make a real difference.

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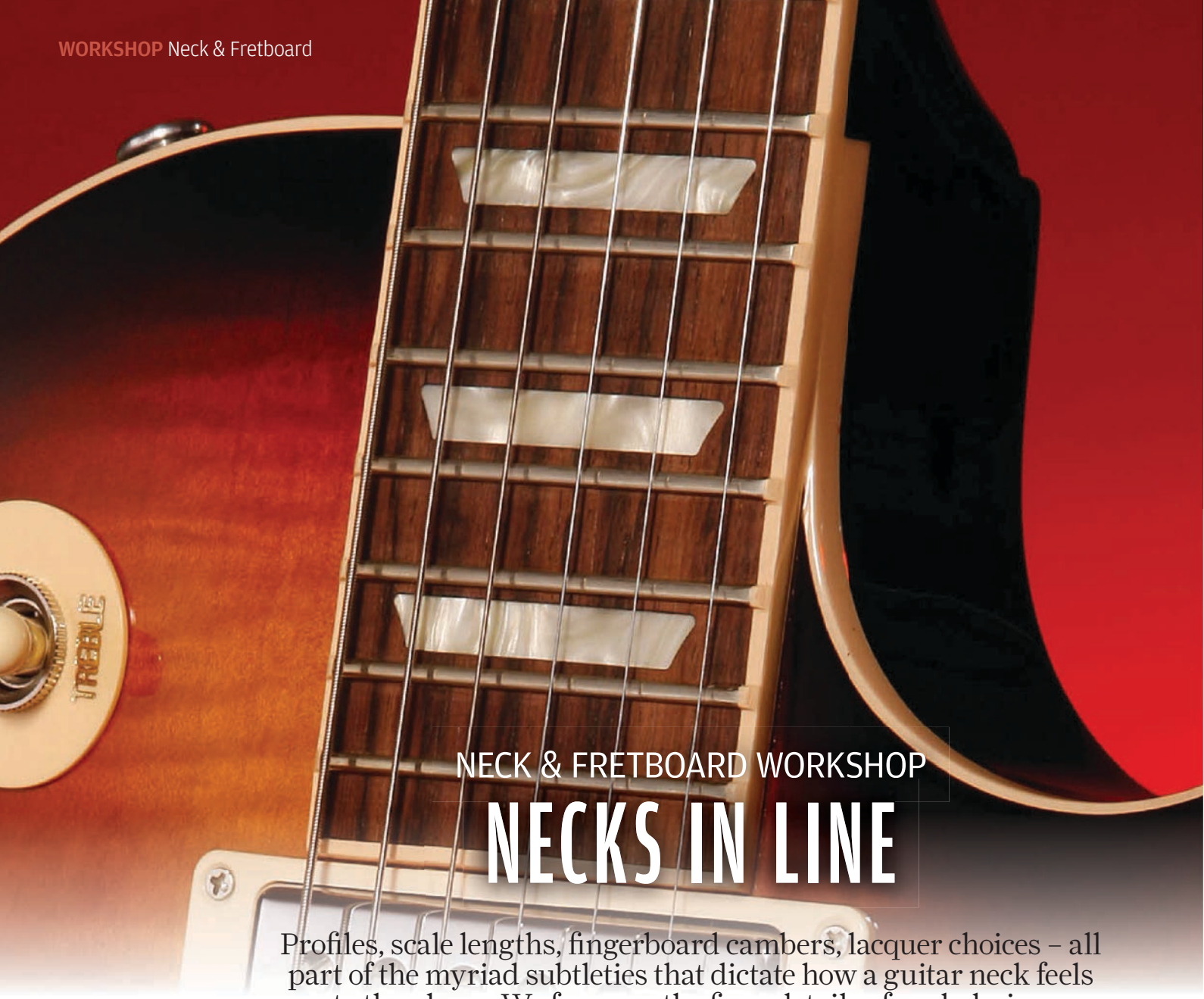


NECK & FRETBOARD WORKSHOP

NECKS IN LINE

Profiles, scale lengths, fingerboard cambers, lacquer choices – all part of the myriad subtleties that dictate how a guitar neck feels to the player. We focus on the finer details of neck design

One of the most important aspects of any guitar, not surprisingly, is how easy the instrument is to play – and it's universally agreed that this is mainly determined by the shape and feel of the neck and fingerboard. The rest of the instrument – pickups, bridge and body timber – though important, can only perform at their best once the neck is playable. In a nutshell, everything starts at the neck..

Neck and neck

Styles of neck construction can vary considerably between guitar makers. Most necks are built from a combination of two types of hardwood: one for the bulk or back of the neck, the other for the playing surface that holds the frets, aka the fingerboard (Fender's one-piece maple neck with integral fretboard is an obvious exception).

The rear section of a neck is shaped from a hardwood blank with long, straight grain to ensure that the neck can be slim but still able to withstand the pull of the strings. Some luthiers use a single piece of maple or mahogany; others laminate three or more pieces together longitudinally with the grain direction of the outer pieces opposing in order to balance stress and reduce the chances of future twisting. Laminating the timber this way is cost-effective and structurally sensible: the laminate is very strong and stable. This consideration ensures maximum strength, especially where the headstock joins the top of the neck, the thinnest and weakest point.

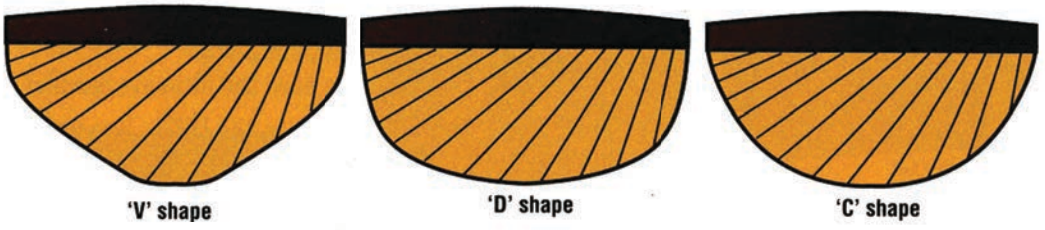
While Fender and Gibson have habitually plumped for one-piece necks and headstocks (on the Strat, Tele and Les Paul), numerous makers today – especially those using pointed, dropped headstocks – splice the headstock to the neck. Done properly, this can save timber, but such a joint is only as strong as the glue and the 'flushness' of the two surfaces.

Fretboards are usually rosewood or ebony, two very hard timbers that don't require a lacquer finish to protect them from the environment and you, the player. Maple is used successfully for fretboards, though being a naturally 'white' timber it requires a finish to protect it from dirt. This has caused some controversy, not least due to Fender's ultra-thick '70s finish that gave maple fretboards a reputation for being 'sticky' and 'slow'.

Modern, thinner satin finishes and higher frets tend to equalise the feel of a maple fingerboard, but

NECK SHAPES

The three most common neck profiles:



where the finish is applied over the frets – as on '70s Fenders – a re-fret can be a bit of a nightmare. Usually the only solution is to remove both the frets and the fingerboard finish, which then has to be reapplied, adding to the repair cost.

Ideally, the combined shape of both the fingerboard and the rear section of the neck should complement one another, helping to make complex fingerings more comfortable. There are many factors at play here: the neck's width and depth, the shape of the back of the neck, the fretboard radius, the frets, the guitar's scale length and, of course, the action. That's why, at G&B, we list these specs in reviews to help you decide whether a guitar might suit you.

Neck shapes

To simplify matters, it could be said that there are three basic styles of neck shape: the C, the D, and the V shape. The C shape describes most Gibson-type guitar necks, a smooth oval in section. The D describes many Fender-style profiles with fatter, squarer 'shoulders' (the sides of the neck). The V shape has shoulders that are often quite steep, and although usually attributed to Martin, the style was also adopted by Fender at times in the '50s and has been frequently reapplied to reissues and signature models. Of course, these categories are broad and the variations manifold, but this should help you to grasp the most commonly-used terminology. In essence, the shape of the rear section of the neck dictates how the neck feels in the palm of your hand. What's comfortable is obviously very personal: some players like the big, deep D-shaped necks of old '50s Les Pauls, others will rave about the super-thin C 'Wizard' shapes of modern Ibanez necks.

Scale length is important here too, as it directly relates to the distance between the frets. Players with big hands may feel happier playing on the longer 25.5" Fender scale than the shorter Gibson 24.75" scale. More and more companies, such as PRS, are using a halfway 25" scale length. The best of both worlds? Maybe.

Apart from the physical size of your hand, the way you fret will affect how the neck feels. If you grab the neck with your thumb around the bass strings, a bigger D shape may be preferable; if you fret in the classical 'thumb behind' position then a thinner neck, often with a flatter back, might suit you best. If you're trying guitars in a shop, the sales assistant should be able to help you pick C and D shaped necks to compare, and a well-stocked store should be able to produce a V neck too, like the one on Fender's Eric Clapton Strat. Ask to try instruments with different scale lengths so that you can gain some idea of the neck shape and string length combination that suits your hands best.

Of course, you may find a great neck on a not-so-great sounding guitar, or vice versa... that's life. If you're rich, an answer may lie in a custom-built guitar: the rest of us will have to get used to a dodgy neck on a great-sounding guitar. After all, if your sound is poor, who's going to notice those solos?

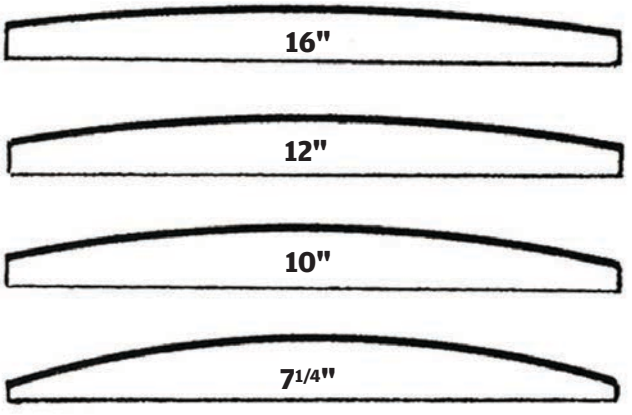
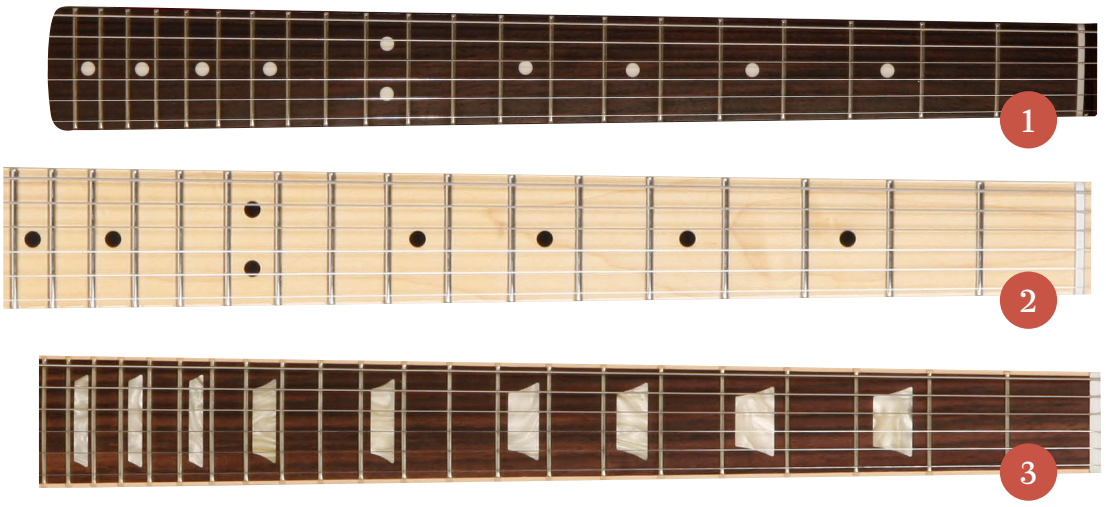
On the subject of tone, the materials used for the neck and fretboard also contribute greatly to the sound of the instrument, although – surprise, surprise – opinions on the effect run in all directions. Whatever anyone tells you, the tone of a guitar is the sum of its parts and your hands, and just because you have a rosewood fretboard it won't make a guitar 'warmer' than another instrument with a 'brighter' maple fretboard. Even highly experienced guitar makers hesitate to be drawn into any precise judgements on the sound of wood. Let your ears and hands make the decision. You may simply like the look of a nice piece of rosewood; it's a valuable resource, so enjoy it.

The camber never lies

The cross-sectional shape of the fretboard – aka the 'radius' or 'camber' – is very relevant to a guitar's playability. Consider, for instance, the plight of players of vintage-spec Strats or Teles who find it difficult to make first, second and third string high-fret bends ring clean and true. Beyond the 10th fret, bending more than a semitone – especially with a low action – can cause the strings to choke out on the upper frets, the sound becoming throttled and buzzy as they approach or pass the centre of the fingerboard.

Most guitars have a 'regular' radius that is the same at the nut >

FIG 1 FINGERBOARD RADII



1 Rosewood allows easy refrets or even board re-radiusing'

2 On maple fingerboards any re-radiusing means a refinish'

3 Gibsons with their flatter-camber boards choke out far less

as at the highest fret. Older vintage and many reissue Fenders have a relatively small radius of 7.25". Such necks feel great to play on; barre chords feel good and first position riffing is easy. However, the small radius causes upper fret choking. Loads of players learn to live with it, while others can't abide it.

Curing the choking on a 7.25" radius fretboard involves a cunning re-radiusing of the frets so that the perceived radius increases as you travel up the board. Though this appears to 'flatten out' the board, it is actually only the frets which take on the new shape; honed this way, the strings are less likely to collide with them and choke out.

The trick is turned by subtle re-cambering of the frets with carborundum or a grindstone so that the top (or crown) becomes gradually lower on the higher frets, the radius at the last fret being anywhere between 12" and 14". This modification works very well but requires extra dressing and reshaping of the low-to-middle sections of the higher frets, which is difficult and expensive. The size or gauge of the frets also has a large bearing on the potential success of the job. Many repairers see this repair as a compromise, since the height of the frets is progressively reduced; you may 'cure' the choking but you now have lower frets, and string bends are likely to be harder to execute. However, on valuable guitars it may be the only option.

The ultimate repair is to change the fretboard radius itself, work which involves removing the frets then 'shooting the board' with a plane to flatten the radius. Once the neck has been re-fretted, the new frets retain a regular height from one end of the neck to the other (bear in mind that on Fenders with veneer fretboards there's often not enough material to reshape). If any refinishing is involved, as there will be if your fretboard is maple, the repair is going to be costly, though it's justifiable since the guitar will play and feel much better.

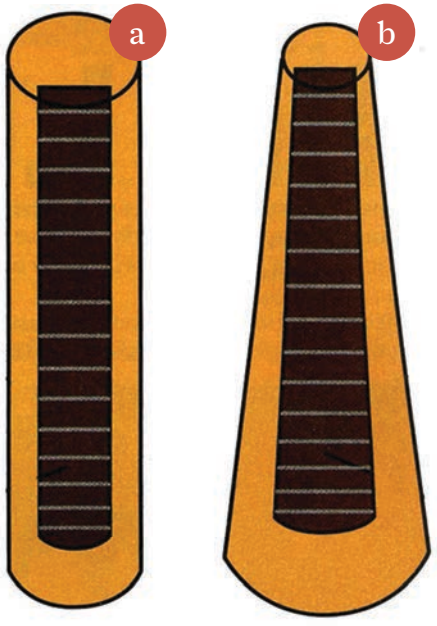
Fender has taken notice of this and have, for example, altered the fretboard radius on the American Standard Series, swapping the vintage 7.25" for a gentler 9.5". Incidentally, this specific choking problem never afflicted Gibson guitars as their radius was, and still is, typically 12", their fretboards being much flatter in comparison. PRS generally employ a halfway radius of 10" to match their halfway scale length. Fig 1 shows the four common radiuses: 7.25", 10", 12" and 16". See how curvy the Fender 7.25" seems next to Gibson's 12".

Compound cambers

Re-working the neck is one option for your favourite guitar, but a much more elegant way out is to swap the neck for one built with a 'compound' radiused fretboard and to stash the old neck out of harm's way, original and untouched. This swap could also involve fitting the new neck with a set of locking machineheads and a graphite nut, a good move for both fixed-bridge and tremolo-bridge guitars.

The compound radius idea is far from new – it crops up on certain classical instruments – but Warmoth in the USA were one of the first to offer a compound radius on a retro-fit neck to suit, for example, a Stratocaster. The Warmoth compound radius shapes the fretboard so that it takes on the contour of a section of a cone – unlike a normally radiused fretboard which takes on the contour of a tube (see Fig 2, left). A typical Warmoth 'compound neck' will start with a radius of 10" at the nut and end with a radius of 16". Many other companies employ compound radii, from Jackson to UK makers Overwater. Still, as we stated earlier, neck shapes and fretboard cambers are only part of the playability story. Before you start thinking of refrets or new necks, get your guitar professionally set up – you'll be surprised what a difference it makes.

FIG 2 NECK SHAPES



a On the left, a 'constant radius' fingerboard with a surface like a tube

b On the right, a cone-shaped compound radius fingerboard, growing flatter towards the upper frets

TREMOLO WORKSHOP

CRITICAL BUT STABLE

Strat trem units can be a vital part of a player's arsenal. However, getting them set up correctly so they can take a hammering and still do you proud is a tricky business. **HUW PRICE** is here to help...

The history of vibrato guitar bridges is long and complicated, but the ruler of the roost – at least until 1954 – was Bigsby. They're still very popular and work efficiently enough within their limits, but they're probably best suited to archtop guitars. The Bigsby B16 for Telecasters was introduced in 1953, but Leo Fender reckoned he could come up with something a bit more sophisticated for his new Stratocaster model. With help from Freddy Tavares, he completely nailed it... as usual..

Maybe Fender was trying to distance his design from Paul Bigsby's by calling his new bridge a 'tremolo'. It's a misnomer, because 'tremolo' actually describes fluctuations in volume rather than pitch. Consequently, Fender amps have 'vibrato' channels when in fact they actually produce a tremolo effect. To avoid confusion we'll just use the term 'trem'.

Of course musicians loved Leo's Stratocaster trem and it had a huge impact on music over the next decade or so, and many would agree that it was Jimi Hendrix who was the first to really explore its full potential. Behind that potential, however, lie a number of limits. The Strat trem is a mechanical device and, like all mechanical devices, it requires proper maintenance, not to mention careful adjustment to function correctly.

Setup information wasn't readily available in the '70s and '80s so many players of that era threw in the towel and simply blocked off their trems, or turned to 'locking trems' from the likes of Floyd Rose and Kahler. At this stage the traditional Fender trem's days seemed like they could be numbered, but once the novelty of two-octave dive-bombs had worn off, it became apparent that 'locking trems' created as many problems as they solved.

When Paul Reed Smith introduced his own trem in the mid-'80s, he was able to apply the lessons he'd learned from years of setting up Stratocasters. His design was surprisingly traditional and it demonstrated that Fender's original design could be made to work reliably as long as the designer has thorough understanding of vital topics such as friction points, proper nut setup and spring adjustment.

How it works

The fundamental difference between the Bigsby units and Fender's design is that the Fender bridge 'floats'. Bigsbys work with fixed bridges and a roller bearing turns to raise or lower string tension – thereby altering pitch. Fender's method counterbalances string tension with the pull of springs housed in a body cavity. The arm moves the entire bridge and the springs and strings supply the restorative forces needed to bring the bridge back into position.

What could possibly go wrong with such a simple system? Plenty, as it happens – but the problems are often integral to guitars in general rather than specific to trems. Unfortunately trem systems tend to expose issues that might otherwise go unnoticed. The primary cause has to be friction. Anything that impedes the free movement of the strings and the bridge will prevent the trem from returning to a state of equilibrium after use. The PRS trem minimised or eliminated friction points wherever possible. You can do the same with your trem when performing routine maintenance. >

TOOLBOX

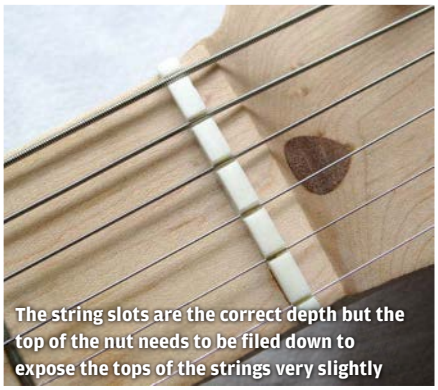
- **Cross head screwdrivers**
- **Allen key for saddles**
- **Ruler**
- **Guitar tuner**
- **Wet & dry paper**
- **Chrome polish**

1 FRICTION POINT 1: THE NUT

Most guitar tuning instability can be traced to the nut. The strings pass through narrow grooves with a lot of downward pressure, so they have a tendency to stick and bind in the slots. Nuts are often pre-slotted (or slotted in a hurry on a production line). Making a nut work smoothly requires time and effort, but it's something you can do yourself. If you notice pops or clicking sounds from the headstock when you bend strings or use your trem, the nut may need attention.

Nuts are often left too high above the string slots, so even if the depth of the slot is correct, the string sits too deep (see pic, right). The top of the nut only needs to be high enough to hold the string securely in the slot, so in effect the top half of the string can be proud of the top of the nut. This helps keep the contact area between the string and the nut to a minimum, thus minimising friction (see below).

Nut files can leave grooves in nut slots. Once the depth of the slot is optimised, the inside surfaces of the slot can be smoothed out with wet and dry paper. Try 1200 or 1500 grit, maybe wrapping the paper around cut-off lengths of string. You can follow up with some polishing compound; we find that chrome polish is particularly effective on bone.



The string slots are the correct depth but the top of the nut needs to be filed down to expose the tops of the strings very slightly

Once the slots are super-smooth, you can add some lubrication. Guitarists have been using graphite from soft pencils for decades, but this leaves the slots looking mucky. Vaseline or wax can also be used, but there is some anecdotal evidence that these can damage guitar finishes. We prefer propriety products like Big Bends Nut Sauce (see pic, below right).

This nicely-polished and height-adjusted nut supports and secures the strings properly, minimising friction in the string slots

After polishing the string slots, try adding some suitable lubricant. Here we're applying some Big Bends Nut Sauce: it's good stuff

2 FRICTION POINT 3: THE STRING TREE

Vintage-style Stats will have just one string tree for the B and E strings, but modern examples generally have a second for the D and G strings. Through careful string winding (see Strings & Tuners) you can get away without using string trees at all.

If you do prefer to use them, then do ensure that the factory spacers are installed under the trees themselves. If the trees are screwed flush with the face of the headstock, the string angle will be too great and the sting will rub excessively against the tree.

Reach for that chrome polish again and buff up the underside of the string tree to make it as smooth as possible. Some players choose to strip the insulating plastic off the wire, thread the string through the centre and then place the plastic under the trees to make things run smoother. Alternatively, another dab of lube can't do any harm.

3 STRINGS AND TUNERS

New strings always require a settling down period before they'll stay in tune. You can hasten this process dramatically by giving new strings a thorough stretch. Don't go too crazy, because you'll snap them. Just stretch a little at a time, with your fingers under the strings, pulling away from the fretboard. Work along the length of each string, check the tuning and repeat until the string has stopped stretching.

Tuners have often been unjustly blamed for unstable trems. If you have diecast tuners, tighten up the screws holding the buttons on to stiffen them up. Vintage-style tuners tend to be pretty stiff, so they should be fine.

The break angle over the nut is important. The well-known US luthier Dan Erlewine recommends an angle of between 5 and 12 degrees. If the angle is too steep, the strings may catch in their slots; if it's too shallow you may experience buzzing sounds from behind the nut, and open strings won't ring cleanly.

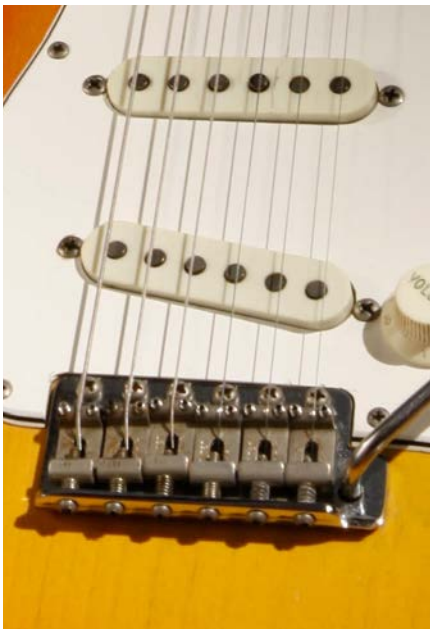
You can set the break angle by wrapping the string around the tuner post. If you take it all the way down you can increase the angle, which may allow you to dispense with the string trees. You can also wrap strings upwards to shallow the angle (see pic below).

Above: notice how the number of turns around the string trees can be used to set the break angle of the strings over the nut. 5 to 12 degrees is recommended

4 FRICTION POINT 2: THE BRIDGE SCREWS

Many of Fender's current trem systems work on knife edge pivots with one screw at each side of the bridge. This was also Leo Fender's preferred arrangement during his latter years at G&L. Obviously a knife edge ensures minimal physical contact, and these trems generally have a very free and smooth action. But what if your bridge has six regular screws?

Fender counter-sunk the screw holes on the underside of their bridge plates to create knife edges, but some cheaper replica bridges won't have this feature. If yours doesn't, you may be able to countersink the holes yourself. You could also try removing the four centre screws. This may appear reckless, but SRV got away with it using 12 and 13 gauge strings – so two screws with a set of 9s or 10s should be okay.

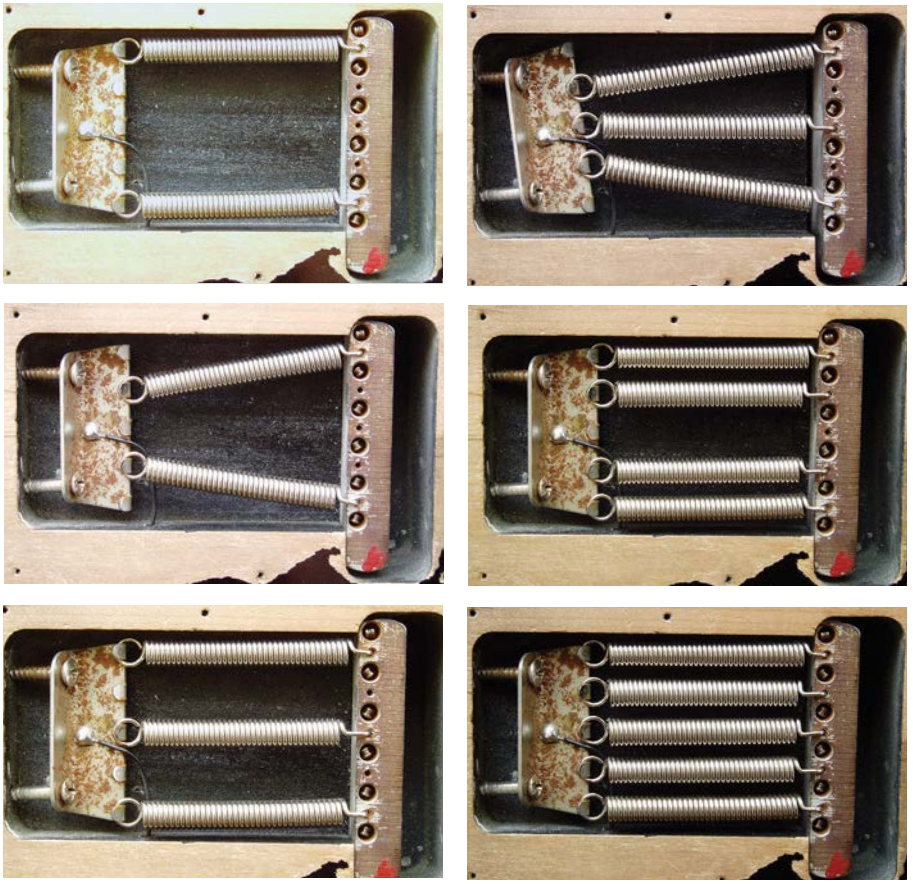
If you want to keep the original looks, you may decide to drill the four centre screw holes in the bridge plate over-size; then the screws can be reinstated without making physical contact with the bridge. This mod is not recommended for collectable guitars! Once again, use a dab of Vaseline or Nut Sauce under the screw heads.

5 SPRINGS & CLAW

Unfortunately we can't provide any hard and fast rules regarding the number of springs you should use or the way they should be arranged. It really all comes down to personal taste, because some players prefer a light feeling trem while others prefer a stiffer setup to stop the bridge moving when bending strings... and to maintain tuning if a string snaps.

The springs are hooked onto a 'claw' that's screwed to the body of the guitar. If it's adjusted tight against the body, it will be pulling the springs hard and the bridge plate may end up sitting tight against the top of the body. This will allow you to dip the trem, but you won't be able to pull upwards.

Most players prefer their trem bridges to 'float', allowing both upwards and downwards movement (it's also thought that Stratocasters sound more 'Stratty' that way because you hear a hint of 'reverb' from the springs themselves). Here's where you need to experiment with combinations of springs and various claw adjustments to position the bridge where you like it and achieve the right feel for your style.

Stratocaster trems allow you to use up to five springs. If you're using a set of ultra-heavy gauge strings, then all five springs may be needed to get the bridge floating properly. At the other extreme, a set of .008"s or .009"s may only require two springs. Most often three springs are used, and they're either arranged straight or angled for a bit more pull. We'll get into fine tuning later, but the starting point for most trem setups is a gap of 1/8" between the body and the back edge of the bridge.



The traditional Fender Stratocaster trem system allows you to use anything for two to five springs. Here we show all the usual combinations and configurations

6 HOW TO SET UP A TREM

This Strat has been set up with a gap of about 1/8" between the back of the bridge plate and the top of the body

If you're installing a new bridge or re-installing one after a re-finish, we'd suggest the following. Position the bridge and tighten the two outside bridge screws until they just touch the top of the bridge before fitting the springs. Install the four remaining bridge screws – being sure to leave them just proud of the bridge plate, not screwed down – then tighten the claw up close to the body, string up the guitar, and tune to pitch.

At this point there should be no gap. If there is, tighten the claw up further or add another spring. If you don't want to pull up on your trem, you may leave it like that. You can also slowly unscrew both claw screws until the bridge is just starting to lift to get a looser-feeling trem with no pull up. Remember to re-tune the strings each time you adjust the claw screws.

If you want a floating trem with some pull up available, unscrew the claw screws a few turns at a time, keeping it square to the body rout, then return the strings to pitch. Work slowly, re-tuning after each adjustment, until you achieve a body to bridge gap of about 1/8" with the strings tuned to concert pitch (see pic, left). If you have ultra-light strings and you can't get the bridge to lift, try removing one spring.

The flaw with this method is that some strings naturally exert more pull on the bridge than others. This is particularly apparent with hybrid sets like skinny top/heavy bottoms. You can get around this by angling the claw to balance out the spring/string tension across all six strings (see pic, above right.)

With Stratocaster trems, you can also fine-tune the response to achieve accurate pitch shifts. For instance, top guitarist Carl Verhayen sets up his trems so that the G string pulls up a minor third, the B string goes up a full tone, and the E string pulls up a semitone. You can try this yourself; just remember that if your trem won't pull up far enough, you'll need to slacken the spring claw on the treble side – and vice versa if it pulls up too much.

This old Strat trem has been set up as recommended by Carl Verhayen and the spring claw has ended up at an angle. It doesn't look pretty, but this Strat really stays in tune and the trem is very playable

Verdict

Remember that, with a Strat trem, everything affects everything else. Once the bridge height and spring tension have been set, you will almost certainly need to re-adjust the height of the string saddles and re-set the intonation. Whenever making adjustments, you need to re-check everything else. Essentially, you should expect to gradually hone a Strat setup rather than nail it straight off. If you can work methodically and remain patient, there's no reason why your trem-equipped Strat can't play smoothly and stay in tune just as well as any other guitar.

PARTS
- 2 x 500k CTS pots
- 1 x CRL 5-way lever switch with spring action
- 1 x WD Music 5-way switch knob
- 1 x Switchcraft 1/4" jack socket
- 1 x Sprague Orange Drop 0.022mF capacitor
- 2 x WD Music Tele barrel knobs
- 1 x black chrome Gotoh football jack plate
- WD Music vintage black/white wire WD Music Products 01223 820082 www.wdmusic.co.uk

TOOLS
- 40W soldering iron
- Resin core solder
- Assorted posidrive and flathead screwdrivers
- Assorted box and open end spanners in imperial and metric sizes
- Needle-nose pliers
- Wire cutters
- Wire strippers
- Craft knife or artist's scalpel for trimming plastic and cloth insulation on wires
- Servisol Super 10 switch cleaner

ELECTRONICS UPGRADE

HEART OF WIRE

Scratchy pots, intermittent output... sounds familiar? The majority of these woes can usually be corrected with a quick clean and check, but when they won't clean up, it's time to upgrade

The build quality and finish of even the cheapest electric guitars is quite staggeringly good these days. However, one area where the manufacturers still cut costs is in the hidden electrical components. Plastic-cased switches, small chassis pots and 'soft metal' jack sockets are cheap to mass-produce, but it's these very components which transfer the juice from your pickups to your guitar lead. These are the usual culprits if your two-month old guitar goes on the blink, and as any guitar repairer will tell you, they can be a nightmare to service. That's why good repairers will strongly recommend that you change at least the volume pot when installing an upgraded pickup, otherwise you're leaving a weak link in the chain which is effectively strangling your tone.

Repairers will strongly recommend that you change at least the volume pot when installing an upgraded pickup

This Ibanez EX series electric is a fine case in point. The pickups work fine (you have to abuse a guitar very heavily to actually break a pickup) and the owner was happy with the basic sound – when it worked, that is. The output was intermittent, with an unbearable loud hum from the earth circuit. On inspection, the pots and switch were completely shot and the solder had become brittle, so we decided to throw out all the old cheaper components, install new higher-specification units and rewire all these new components with some swanky cloth-covered wiring 1.

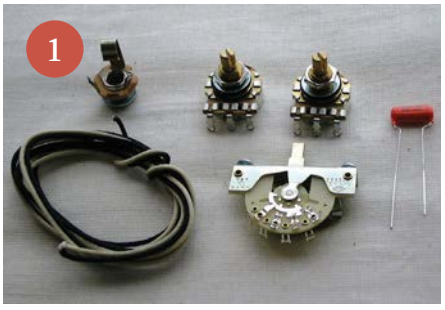
Dissasembly

Our Ibanez 2 has its original humbucker/humbucker/single coil configuration with a five-way selector and master volume, master tone control configuration. Laying the guitar face down on a smooth, soft surface (an old blanket or soft towel makes a fab non-scratch workbench covering) we start by removing the back plate to reveal the internal organs. Any guitar with this kind of rear access (such as a Les Paul) can be left strung up and in tune throughout the process. If you're working on a Strat-type then the strings need to be slackened or removed to flip the scratchplate over. Before you do anything else, spend a few minutes drawing an accurate, detailed diagram of the original wiring layout. Don't imagine you'll remember where the wires go – you won't.

Next, pop off the control knobs to reveal the hexagonal nuts that hold the pots in place 3. Remove them with a box or open spanner; you'll need to reach inside and hold the chassis of the pot. If you use a posidrive screwdriver you'll make quick work of the switch locating screws and the 'football' side-mounted jack plate 4.

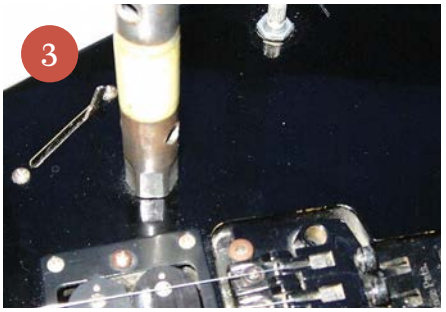
Flip the guitar back onto its front and locate the three pickup leads 5 as they enter the control cavity just behind and above the volume pot (on humbuckers these are usually multi-core wires with a bare stranded earth wrap and two or more conductor leads with a colour-coded insulation covering. Standard single coil pickups have just two leads, one from each end of the winding). There will also be a fourth wire (usually black) entering the cavity and soldered to the back of a pot. This is the earth wire that feeds from the bridge or vibrato spring claw. This wire is important so don't ignore it, pull on it or cut it. Disconnect it from the pot 6 together with the other wires and, if it's long enough, fold it back out of the way and tape it to the guitar body. Don't forget to reconnect it, or your guitar will sound absolutely shocking. You have been warned.

Next, trace the pickup wires to the switch and make a further note of where they go; then either unsolder them or simply clip them off at the switch terminal. Label them N, M or B (neck, middle,

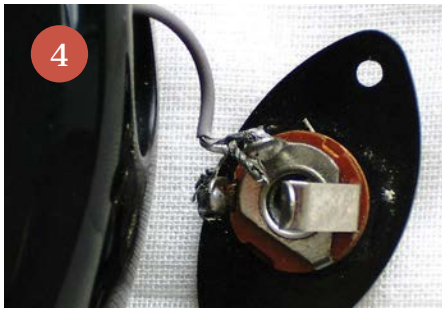


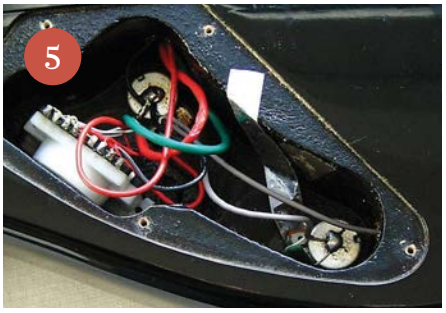
1 Here's our pile of gleaming new components: a pair of CTS pots, a high-quality CRS five-way switch, a Switchcraft jack, an Orange Drop capacitor and, of course, that cloth-covered wire

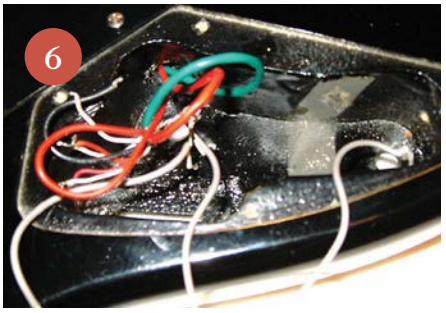
2 Our patient, an Ibanez EX, has decent enough pickups but is suffering from worn-out components that weren't exactly state of the art in the first place. Let battle commence

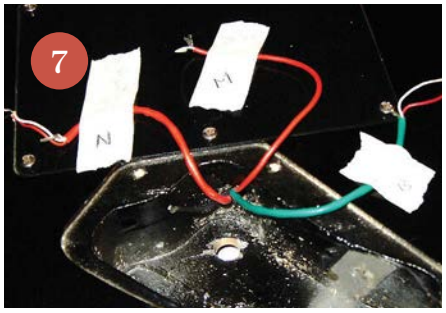


3 Pop off the knobs and remove the nuts with the correct-sized box spanner









bridge) and then tape them out of the way as well 7. As we're upgrading from a single-sided plastic switch to a more traditional double-row Strat-type switch you will need to source an alternate switch diagram, but that's easy – the web is a great resource for this type of information.

Now remove the pots, switch, jack and any remaining wiring and immediately throw the lot the bin. Don't be tempted to save it for use at a later date; life is simply too short to go to the trouble of fitting old parts only to discover that they were knackered in the first place.

Preparation

It's now time to prep the new components, as they all require a little attention before installation. Firstly check that the potentiometer shafts fit through the existing holes on the face of the guitar 8 as higher spec components are often slightly larger and more rugged than the ones they're replacing.

On this guitar we needed to widen the diameter of the holes using a dedicated hole reamer, but you can do the same with a sharp round file and a little patience (it's a good idea to protect the finish with masking tape and work inwards towards the cavity rather than outwards, where you run the risk of chipping the finish around the holes). Secondly, check that the pot shaft protrudes enough to take the knurled (inside the cavity) and flat (on the face of the guitar beneath the hexagonal nut) washers plus the nut with a couple of threads visible when tightened. This may take a bit of trial and error but is worth the trouble to ensue a solid fit.

All okay? Great. Now remove the pots again and seat them in a small vice, if you have one, (or a cork block with a suitable-sized hole drilled into it) ready for you to start tinning 9. Any surface that is being soldered needs to be 'tinned' first, and that includes the lugs on the output jack 10, the pots' metal casings and the wire tips. Tinned parts allow the actual soldering to take place much quicker. The surface on the back of the pot casing also needs to be cleaned of any trace amounts of grease caused by handling or oxidation to ensure a clean, strong solder join. I use P320 Electro Coated finishing paper to do the job, although a small metal file or sharp screwdriver will be sufficient to scratch through to the shiny metal surface.

Select a pot for volume (either will do) and turn it so the three lugs are facing toward you as you look down on the back of the casing. Using needle-nosed pliers, bend the right hand lug back to touch the casing and then solder it to the case 11. It's this connection that turns your neutral pot into a volume pot by sending the signal to earth when the volume pot is rolled back. Touch the part to be tinned with the soldering iron, allow it to heat up, and then flow the solder over the part, NOT the soldering iron's >

4 Removing the jackplate reveals a cheap socket.

5 Off with the back plate, and identify the three wires coming from the pickups

6 Wires disconnected. You have drawn a detailed diagram, haven't you?

7 With an empty control cavity, we can label the wires coming from the three pickups and tape them out of the way

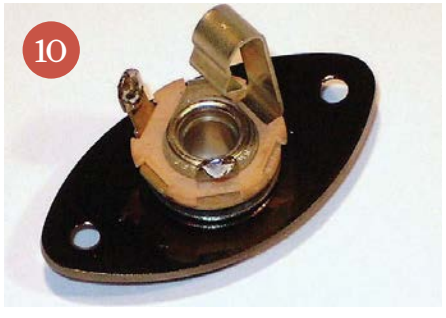
8 Check the new pots fit. The holes might need a touch from a file or reamer

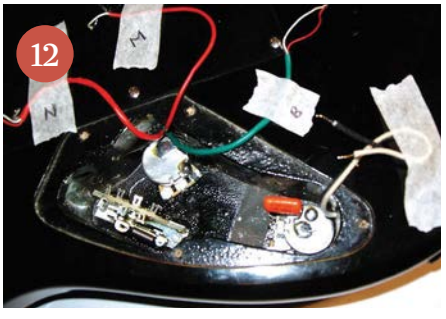
9 Prepare all the parts and tin the whole lot in one go. A small vice is invaluable

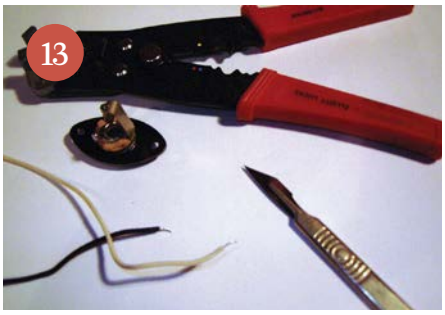
10 Practise tinning on the easiest bits fist. Pot and jack lugs are the simplest

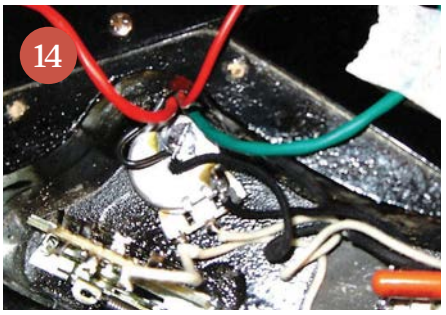
11 Tinning the pot casings is hardest. Prep well and use an iron of the right power

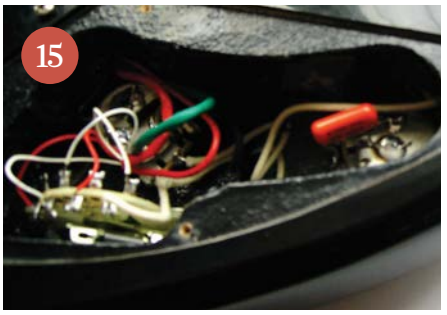
12 Now we're starting to re-populate the control cavity. All lugs, casings and wire tips should be tinned before this stage. Note the posh new capacitor on the tone pot











13 Switchcraft is the name in jack sockets: here's ours ready to go. Now's the time to replace the plastic jack plate with black chrome. It's as important to tin the leads as the other components

14 Now we're using out new cloth-covered wire to make the connections between output jack, tone and volume pots, and switch. It's probably best to leave the pickup wires until last

15 Rewiring complete, you're ready to plug in and check that everything's working

16 A soldering gun is optional: a 40W iron is essential. Use a proper stand!

17 Bits and pieces you need: a Posidrive screwdriver, Servisol switch cleaner/lubricant, miniature flathead screwdrivers, a round file, a reamer – if you're really serious – and box spanners

SAFETY TIP

Solder can spit and spill when heated, so wear safety goggles and protect your guitar and surrounding surfaces with cloth. Double and triple-check that you have switched off or unplugged the soldering iron after use – these things get white hot and are extremely dangerous if left on!

tip. You'll know a good solder join when you see it: it'll be bright and shiny rather than a dull and lifeless grey. Next, add two separate patches of fresh solder to the back of the casing to accept the earth wires later on. Ensure your soldering iron is good and hot, and work quickly to avoid over-heating the track and wiper inside the pot.

When you're sure you're happy with the soldering, set the pot aside and clean the back of the second pot (now, by default, the tone pot). Tin the middle and right hand lug and also solder two separate tinned patches on the back of the casing. You now need to install the capacitor between the middle lug on the tone pot and the pot casing. It's this capacitor which bleeds off the treble frequencies on the tone pot. Capacitors are fragile and are easily popped if overexposed to heat, so use a flat-head screwdriver between the capacitor and the solder join to act as a 'heat sink' to absorb most of the heat away. With the now pots ready, tin the terminals on the five-way selector switch and carefully install all three components in the control cavity 12 .

If the existing jack plate is plastic, now is a very good time to upgrade it to a nice sturdy metal plate. Tin the terminals 13 and solder a 150mm length of live (white) and earth (black) shielded wire to the jack. The 'live' white wire connects to the jack tip terminal and the black 'earth' wire to the barrel or inside of the jack. Once soldered, push the two wires through the channel on the side of the instrument and into the control cavity and test the fit by inserting a lead into the jack. The lead should fit snugly with a pleasing 'clunk'. If it does you can remove the lead and move on.

With all the components in place, it's now time to start hooking it all up 14 . Follow your diagram and, using the replacement trimmed wire, join the switch and the tone pot to the volume pot. At this point replace the original earth wire mentioned earlier to the casing on the volume pot before soldering the jack socket earth lead to the same point using a heat sink to keep the wires in place while the solder cools. Then run a piece of black 'earth' wire from here to the tone pot casing to complete the basic circuit earthing loop. Keep it neat and tidy, but allow sufficient slack so components can be loosened and removed for inspection or maintenance without the need for unsoldering.

It's now time to re-solder the pickup wires 15 that you carefully labelled earlier. Strip and twist a 10mm section of the earth wire from each pickup lead and tin them before attaching to the as-yet-unused patch of tinning on the volume pot casing – things can get a little crowded and fiddly at this point, but it's important to try and avoid twisting the three earth wires together if possible as it makes removal of a single pickup a serious pain.

Trim, strip and tin the remaining power leads from the pickups and attach to the switch as per your new diagram for the double-sided switch. Tighten the jack plate screws, squirt a little Servisol switch cleaner/lubricant into the openings in the potentiometer's casing, and then plug in. If all is well then replace the back plate and seat the new knobs over the new wider-diameter pot shafts.

These new parts should stay usable for many, many years if they are regularly serviced and cleaned. Check out our sidebar on page 64 for details of all the tools you need – you can see some of them the pictured below 16 17 . Then follow the instructions, and hopefully you'll be enjoying a guitar with a clean signal path and a blissful lack of earth hum and crackle.

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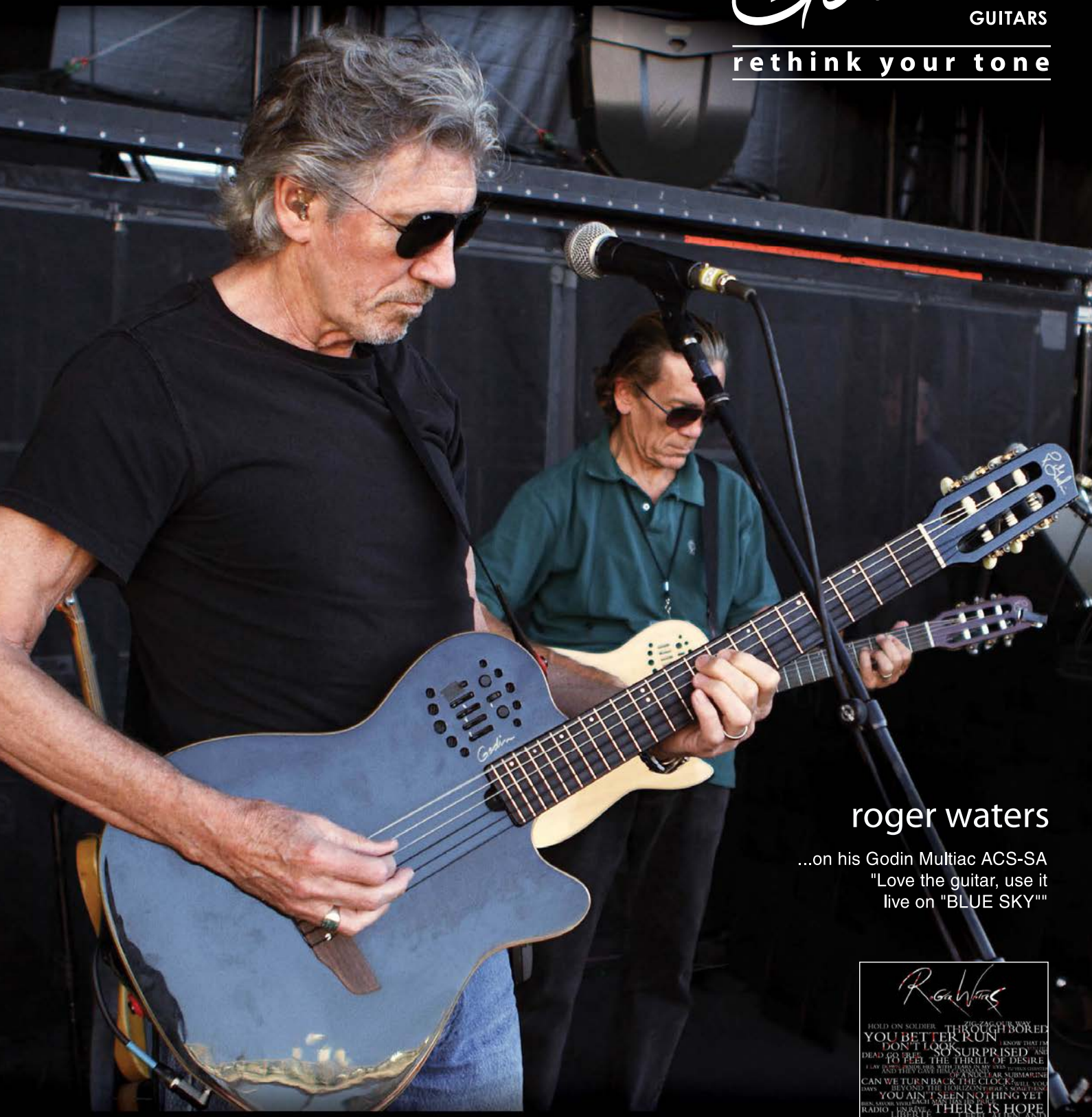

roger waters

...on his Godin Multiac ACS-SA
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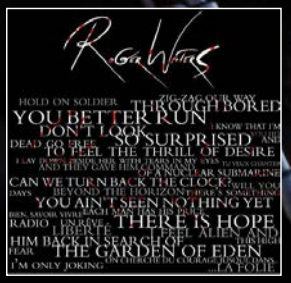
live on "BLUE SKY""



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SUPERSTRAT PROJECT

HOT ROD MODS

Though you can buy a new Fender with almost any pickup configuration, modifying a model to your own taste can still sometimes make perfect sense. **HUW PRICE** helps convert a '50s reissue into a rock machine

The chances are that most guitarists are would-be guitar designers to some extent. Of course, we aren't all inclined to sit there with a paper and pencil doodling body and headstock shapes, but how many of us have found ourselves dreaming about pickup swaps, wiring schemes and various other modifications at one time or another?.

It carries on through the generations – but these days guitar modders can try out their ideas online before they buy the wrong parts or do any damage to a precious instrument. G&B reader Dafydd Jones used a website called Kisekae (www.yajimastringworks.com) to help him decide on the parts and the look he wanted for his new Stratocaster project. The design program allows you to drag and drop guitar parts onto a any type of guitar body to see how the finished guitar is going to end up looking.

Starting out with a Mexican-made Fender Stratocaster, Dafydd wanted a beefier and more powerful instrument for the rock and heavy blues styles he predominantly enjoys playing. However he likes single coil tones too, so he got in touch to see if we could do something to help. We recommended a Super 5-way switch that can be used with coil-tappable humbuckers to provide a variety of sounds. So once Dafydd had acquired the parts, he turned up with his guitar, and Project Superstrat was ready to go.

1 REMOVING THE SCRATCHPLATE

Before starting a project like this it's wise to assess the condition of the guitar. Since the guitar was only a couple of years old the frets were in good shape, and it was clean and well cared for. Even so, we agreed to perform a basic setup once all the parts were swapped over.

The first job was to remove the scratchplate along with all the pickups and controls. We could have recycled the volume and tone pots, but keeping the scratchplate and controls intact would give Dafydd the option of returning his guitar to stock should he ever change his mind or decide to sell it. Besides which, the original Fender pots were 250K, which would probably make a humbucker equipped guitar sound too dark. To maintain clarity and definition, 500K or even 1M pots are recommended for humbuckers.

On this particular guitar four wires needed to be detached. Three had black insulation and were the ground connections from the output jack, trem spring claw and the conductive paint in the pickup and control cavity routs. These were all soldered to the casing of the volume pot and, since there was so much slack wire, we decided to snip them off rather than attempt to de-solder. The fourth wire was the white insulated signal wire connecting the centre tag of the volume pot to the tip of the output jack.

Above: these are the wires you must de-solder or snip to remove the scratchplate assembly

2 FITTING THE NEW SCRATCHPLATE

One of the problems that everybody encounters with aftermarket parts is that they don't always line up perfectly, and some barely fit at all. The Boston-branded scratchplate Dafydd had sourced from Amazon was a decent quality item with a subtle mint green hue. Even so there were some minor issues.

With the original scratchplate removed I was able to carry out a trial fit. The good news was that the new guard looked fantastic on the off-white body, but the bad news was that the screw holes on the bass side of the neck didn't line up. In fact, one was in a completely different location. The screw holes on the treble side were spot-on, but I would have been forced to screw the others in at angles if I wanted to re-use the original screw holes.

The solution was simple. Fold some sandpaper over the end of a long wooden match and twist the match to round over the corners. In a short while you should have turned the end of the match into a small rounded dowel. Next you should fill the screw hole and cover the end of the match with some strong wood glue that will set hard. I get the desired results with Titebond original.

Next, push the rounded end of the match into the glue-filled hole, snap it off about half an inch proud of the surface, then gently tap it snug with a soft mallet, taking great care not to dent the finish or to snap the match. Simply repeat the process for each screw hole and set the body aside while the glue dries. Preferably this will be overnight, to make sure.

When the glue had set, I used a Stanley knife blade to cut the tops of the matches flush with the body. If you try this, be extremely careful with the finish... and your fingers. Push the blade towards the routs, not away, to ensure that if you do slip and damage the finish, it will be in the area hidden beneath the scratchplate.

The second problem we had to address was that the holes in the scratchplate were too narrow for the shafts of the CTS pots Dafydd had bought for the project. It's quite a common problem when modding guitars, because manufacturers in the Far East tend to use metric measurements and US manufacturers work with imperial.

We could have drilled out the holes to widen them, but I prefer to use a reamer tool. To compensate for the taper I reamed from both sides, continually checking until I had just enough width for the pot shafts.

Above: the new scratchplate was a good fit but the screw holes didn't quite line up

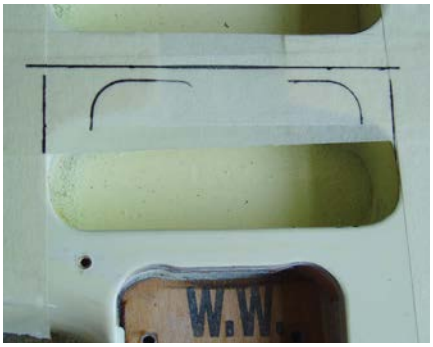
We squeezed wood glue into the screw holes and tapped in rounded-off matchsticks to plug them

You can use a fresh blade to trim the tops of the matchstick plugs flush with the finish

Rather than drill out the scratchplate holes to widen them for the new pots, we used a reamer

Here the volume pot hole has been widened, and we're about to move onto the tone pot hole

3 MARKING OUT THE NEW PICKUP ROUT



Left: masking tape was placed over the finish in the area where wood needed to be removed to accommodate the new pickup. We traced around the pickup hole then added a bit of extra clearance

Fender's Strat bodies are made with various types of pickup routs. Obviously three single coil routs are the traditional way, but some have humbucker routs at the bridge and neck, while others have the 'swimming pool' rout that allows the various factories to install any pickup combination. Dafydd's Strat was already routed for a bridge humbucker, but fitting the neck humbucker he wanted meant I had to remove some wood to accommodate it.

Positioning the new scratchplate accurately on the body showed that wood only needed to be removed from the bridge side of the rout. I covered that area of the body with masking tape, re-positioned the scratchplate, and traced around the scratchplate's neck pickup cut-out. As you can see from the photo, I then marked the intended rout line an eighth of an inch away from the edge of the pickup cut-out to gain a bit of extra clearance, and finally drew two lines to join it up with the edges of the existing rout.

4 ROUTING OUT

It's possible to remove excess wood with a chisel, but the proper way to do it is to use a router. I bought mine used for a little under £15; in fact the bearing guided router bits I used for this project cost more than the router itself.

Routers are terrifyingly efficient tools and you must never attempt to make cuts freehand. I transferred the intended rout shape onto a piece of scrap ply and cut it out with a jigsaw to make a routing template. Try cutting just inside the lines and tidying up the edges with a rasp, file or sanding block to make them straight and smooth. Don't worry about rounding off the corners – the bit's rounded guide bearing will take care of that.

The routing template was clamped onto the body to hold everything in position. Some people use double-sided tape, but on our Strat the finish under the scratchplate had a tendency to chip and I didn't want to risk inadvertently removing the finish when removing the router template.

Don't try cutting to full depth straight away. I used a shallow 3/8" router bit for the first two cuts and allowed the bearing to be guided by the router template. I swapped over to my 1" bit for the final cut: if I had attempted to use the 3/8" bit, there would have been nothing to guide it as it reached the wire channel area. I set the 1" bit 1/16" above the bottom of the cavity and the guide bearing was able to make contact with the template all the way around. If you look at the photo, the areas of exposed wood show how much was removed. The wood we cut away only lightened the body by 20g – less than half the weight of a PP3 battery.

The router template might look a bit rough and ready, but the pickup cavity will be smooth

For the very first pass we used a 3/8" router bit and cut only to a one-third depth

We used the same 3/8" bit for the second cut then swapped over to a 1" bit for the final cut. When we had finished, the pickup cavity was big enough to accommodate a humbucker. You can see the router bits we used in the neck pocket

5 LOADING THE NEW SCRATCHPLATE

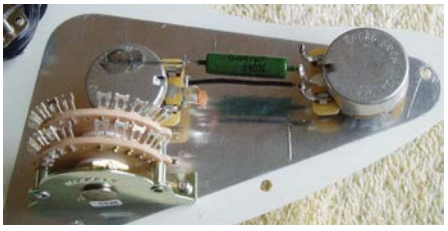
The first step towards completion involves fitting the two 500K control pots and the Seymour Duncan Super 5-Way switch. These switches are double the thickness of a standard Strat switch, so when installing one into Strat with a regular control rout, the connection tags should be oriented towards the centre otherwise it won't fit. It's colour-coded for Seymour Duncan pickups, but since Dafydd had chosen a Duncan TB-4 Trembucker for the bridge and a SH-4 for the neck, that was fine (and do check out the Seymour Duncan website – it's a fantastic resource for modders, with clear diagrams of just about any wiring configuration you can think of).

First I connected the recommended 0.047uF capacitor for the tone pot. Since we were going with two rather than three controls, I was able to bridge the gap between the two pots with the capacitor itself, point to point style. We used a nice new old stock Russian paper-in-oil capacitor bought from eBay. Taking inspiration from Gibson's 1950s wiring schemes, I connected the tone circuit to the output (centre) lug of the volume pot. The idea is that any treble bleed through the tone circuit remains constant regardless of the position of the volume pot. Since hot humbuckers tend to sound quite dark, I soldered a 0.002uF treble bleed capacitor across the input and output tags of the volume control; this helps to retain clarity when the volume control is turned down to clean up an amp.

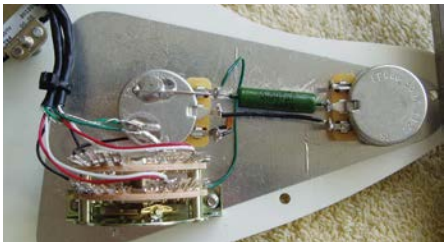
With all the preliminary wiring done, it was time to install the pickups and hook them up to the Super 5-Way switch. Although Trembuckers are supposedly designed for Strat-type guitars, their mounting screws were too long for the depth of the body routs. Sawing and filing metal in the vicinity of a pickup is inadvisable because the pickup will end up covered in metallic dust, so I simply snipped the excess off with a strong pliers.

The switching arrangement Dafydd wanted was neck humbucker, both pickups and bridge humbucker, with single coils in the in-between settings. I found the correct schematic on the Seymour Duncan website and followed the instructions. However, there was a problem: rather than having the two inner coils on the in between settings as described, we got the outer coil of the neck humbucker. This could be because the JB SH-4 Dafydd bought was actually a bridge rather than a neck unit. Either way it worked out well because we got the fatter-sounding neck coil under the octave harmonic along with some extra tonal variation because the single coils were spaced wider apart. The polepieces of the neck pickup lined up perfectly too.

With the three ground wires reconnected to the body of the volume control and the white jack tip wire re-connected to the centre lug of the volume pot, the time had come to put the guitar back together. Whenever you rewire a guitar, especially when it's a wiring scheme you haven't used before, it makes sense to test everything before screwing down the scratchplate and re-stringing; that way, if you have made a mistake, fixing it will be a lot less work. Thankfully the wiring diagram we downloaded was so clear that everything worked first time. However we did feel that the 0.047uF capacitor rolled off too much treble, and we eventually changed it for a 0.022uF.



Above: the pots and Super 5-Way switch were installed and initial connections made first. Note the treble bleed capacitor on the volume pot and the way the tone capacitor is wired point-to-point



The pickup wires have been soldered to the switch as per the Seymour Duncan schematic. We prefer to keep cable runs as short as possible and the excess green wire we snipped off was used to connect the switch to the volume pot

The verdict

We were really pleased with the way this Strat modification turned out, but the only opinion that really mattered was that of Dafydd, the owner. Here's what he had to say: 'I've always wanted to have a custom build guitar, and now I do. It looks amazing and the sound is stunning. All my mates think that it's fantastic, and even my parents cannot believe the sound from it... so much so they don't make me put my headphones on all the time! Since I've had it back, I haven't played any of my other guitars and I have joined another band. It is an absolute gem and thank you so much for customising it for me.'

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HEADSTOCK BREAK REPAIR

ON WITH ITS HEAD

Attempting to fix a headstock break on a valuable guitar is not advisable, but here **DAVE WALSH** shows how you can save a cheapo beater that's been beheaded with a few tools and some know-how

Guitar necks often have of a weak spot just below the headstock. It's caused by a number of factors: the direction of the wood grain, the truss-rod routing – particularly if the rod is adjustable from the headstock – and the amount of string pressure on the head itself.

The majority of these breaks occur on mahogany-necked guitars. Mahogany is a fantastic tone wood and easy to carve but it's relatively soft in comparison to maple, the other common neck wood, so if you're in the market for a secondhand Les Paul, always check this area for evidence of a repair. On some guitars it doesn't take much more than a slip off a strap or a gentle fall from a stand, and bang – the headstock cracks open or breaks right off.

Neck breaks generally fall into three categories: firstly, a clean type where the headstock is still attached and 'flaps' open (this is the easiest to fix, especially if repaired immediately); a diagonal split through the headstock – again simple if caught early; and the worst of the bunch, a completely broken-off headstock. If the break is badly splintered or contains multiple fractures, the repair may involve routing and inlaying wooden reinforcing splints into the neck and headstock.

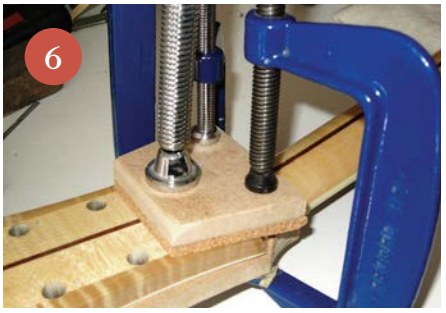
If you're unlucky enough to experience a break, immediately detune the strings down to slack and place the guitar gently in a hard case together with any loose chips of wood or paint, all of which are vital to restoring the guitar to its former glory.

We're going to look at a couple of headstock breaks – a mahogany headstock crack on a Baby Taylor and a less common maple break on a Gibson J-200. The Taylor arrived with a brutal-looking split diagonally across the headstock and through the A tuner hole 1. In fact the head is held together almost purely by the plastic Lexan face veneer, which has prevented the head from spitting clean in two. On the J-200 the break has fractured with a smaller, shallower crack

1 This Baby Taylor toppled gently onto a carpeted floor and the headstock snapped right across in a diagonal line following the grain. It goes to show how careful you need to be with mahogany necks

2 This recent Gibson J-200 reissue met its doom during a radio recording session. It's a short, clean break, but it'll be near-impossible to completely disguise the glue line in the pale-coloured maple

3 A natty way to hang onto bridge pins and saddle is simply to tape them in place



above the more obvious break 2. How accurately a crack will go back together is the one determining factor to how successful a repair will be. In both cases, using a plastic headstock face has prevented a more serious break and both should prove pretty straightforward to fix with the correct adhesive and clamping method.

Start by removing the strings and use a piece of masking tape to secure the bridge pins and saddle in the bridge 3. Next, remove the tuners and truss rod cover, ensuring that you don't add any additional stress to the headstock as you do so, then lay the guitar face down on a flat, soft surface.

The crack must be clean and free from dust, dirt and any grease. A bit of patience is essential before slapping a load of adhesive in and whacking on a couple of clamps. Not all cracked headstocks want to go back together as easily they came apart, and it can be very difficult getting the edges to line up perfectly for the entire length of the separation. You must ensure that the surface on either side of the break will line up and come together when the clamps are on. Fortunately, on both of these acosutics most of the edges are intact and there are no missing pieces of wood.

Once the damage has been assessed, it's time to make some clamping cauls. Cauls are essential – you must never attach a steel clamp directly to the headstock – and I often fabricate individual cauls for specific jobs. They can be made from many different materials, but we're using 10mm MDF covered with 5mm cork sheet. These materials are cheap and easy to source; cork is firm enough to be clamped hard but also 'gives' a little at the curved neck/headstock join.

Begin by making a caul to cover the headstock face. Loosely trace around the headstock and cut the caul with a bandsaw if you have one, or a jigsaw or a coping saw 4. Sand any rough-sawn edges smooth and lay the caul flat onto some 5mm cork sheet (don't pull the tiles off the bathroom floor; it's readily available in your local art shop). Mark around the caul and cut with scissors or a craft knife. Attach the cork to the MDF caul using double-sided sticky tape 5.

Repeat the process for the rear of the headstock, taking into account the differences in shape and length. We made a standard oblong for the Baby Taylor and a shorter, wider caul for the rear of the J-200. Cauls don't need to be a work of art: they just need to cover the break area and have sufficient width to accept as many clamps as necessary. Three or four clamps will be used for an average repair. To prevent any adhesive from sticking to the cauls, cover them in a non-stick or adhesive-resistant substance. By a strange quirk of fate, the thin transparent plastic pouch that many guitar strings come packed in is ideal. Cut the packing to a nice neat square (trim off any ridges, too) and then attach it to the cork side on the caul using masking tape or double-sided tape. Now the caul is ready for use, and any adhesive that escapes the clamped crack – and there will be some – can be easily removed.

Okay, now DRY run the clamping. This is an essential stage, as once the adhesive is applied it is very difficult to assess how well the clamping works 6, 7. Once you're happy that the cauls and clamps will close the crack tightly, mix the adhesive. We are using Araldite, a two-pack epoxy resin which is actually stronger than wood when set but also has excellent gap-filling properties and can be sanded flat. Don't be tempted to use white wood glue – it simply isn't strong enough.

For Araldite (use the slow-setting blue/white pack only) mix equal resin and hardener together on a scrap MDF offcut to achieve a thick paste 8. Be careful – this stuff is an industrial-strength bonding product. Mix enough for the job, but there's no need for messy haste as the adhesive remains usable and fluid for at least an hour, depending on ambient temperature.

Apply the adhesive into the crack using a feeler gauge (the 0.05 to 1mm type used for spark plug adjustments) and/or a spatula. It's vital to get the adhesive all the way to the bottom of the crack – a syringe can be used, but for our >

4 Cutting out the clamping caul for the headstock face. A handsaw would do fine

5 The finished front-face caul with cork simply attached by double-sided tape

6 Here's a rear view of the dry run. You need to make sure the crack will close tight

7 Another dry run, this time on the Taylor. We're using a full-length caul for the rear

8 Slow-setting two-pack Araldite is hardcore stuff. Mix the glue very thoroughly

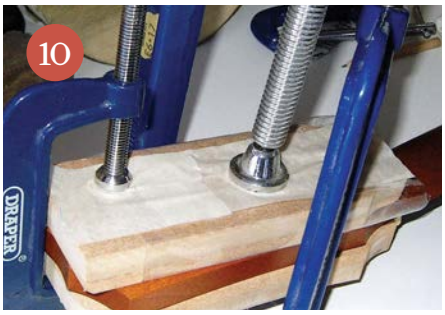
9 You need to get the glue right into the crack. A metal feeler gauge is a good tool

TOOLS

- **Araldite slow setting epoxy resin (blue & white tubes)**
- **White spirit**
- **10mm MDF sheet**
- **7mm cork sheet**
- **Set of G clamps**
- **Plastic string pouch**
- **600 and 1200 grade wet/dry paper**
- **T-Cut and soft lint-free polishing cloth**
- **Feeler gauges**
- **Artist's scalpel or craft knife**
- **Small file set**
- **Double-sided sticky tape**

SAFETY TIP

White spirit is extremely flammable. Any paper towels soaked in it need to be carefully disposed of in a bin OUTSIDE your home



10 We ended up using three G clamps to cover the Taylor's headstock-long long crack

11 Clean away surplus glue with white spirit, and after an hour you can remove the clamps and cauls, clean again, and then reapply the clamps. Repeat several times

12 After 24 hours, the glue will be hardened enough to allow filing away of the excess

13 Use 600 and 1200 wet-and-dry to smooth the crack without removing any finish

14 The Taylor's tough poly finish doesn't need quite the delicate treatment of the J-200

15 Without a pro polishing wheel, you can simply use T-Cut and a lint-free cloth

16 The J-200's nitro-cellulose finish needs care - you could easily sand through it

17 The Taylor's mahogany neck hides the repair really well. You'd hardly know

18 Not invisible, as we predicted, but the repair is certainly stronger than the original wood

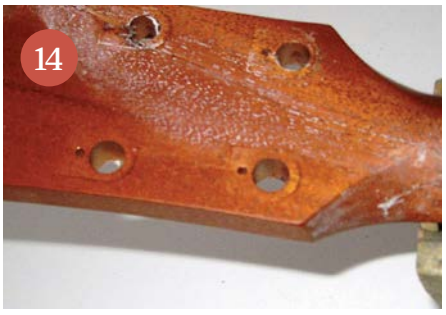
breaks a thin feeler gauge was adequate 9. Now push the join together. The excess adhesive will be squeezed out, so get ready with some kitchen towel and a small bottle of white spirit to wipe away the excess. Keep cleaning it away and ensure that none has leaked onto other parts of the guitar. Clean any adhesive from your hands and then line up the cauls and apply the first clamp to hold them together like a sandwich, with the headstock as the meat/filling 10.

Apply the remaining clamps and be sure to quickly wipe away any remaining squeezed-out glue 11 before placing the guitar onto a flat surface with the clamps taking the weight. Thoroughly clean any adhesive from the feeler gauge and other tools.

Wait about an hour and then carefully remove the clamps and cauls – holding the join together as you do so – and, using white spirit, wipe away any adhesive that has squeezed out (this reduces the amount of cleaning up once the adhesive is dry and the clamps are off). Also remove the excess from the plastic covering on the cauls, and re-apply the clamps. This can be repeated periodically for approximately two hours before the curing process starts in earnest. After any final clamps adjustments, leave the job to dry.

Now wait for 24 hours for the adhesive to set – and that means a complete 24 hours, not just overnight – then remove the clamps and cauls, and you'll find a solid headstock once again with small ripples of adhesive along the original break line. Remove these ripples with careful filing using a small file before sanding with 600 and lightly-soaked 1200 grade wet/dry paper 12, 13. The aim is to flatten the join without removing any of the original finish. Work carefully – a little patience will improve the overall result enormously. Bear in mind that thin nitro finishes 'blend' nicely back into each other, whereas thick polyester is far tougher to rub through or feather together. Once the area is flattened 14 it can be polished – either on a polishing wheel or with T-Cut, a soft lint-free cloth and some elbow grease to achieve a smooth, blemish-free surface 15, 16.

At this point the guitars are perfectly playable and the headstock areas stronger than ever 17, 18. Once the joins and surrounding wood have completely 'settled' (usually after two to three months) the finish could be touched in to hide the repairs. The Baby Taylor could have the headstock 'bursted in' to cover the break but the clear finished maple on the J-200 will be a lot trickier and any refinish work here could draw more attention to the repair. In general, I advise against refinishing as the damage is to the rear of each instrument. Once again, do not experiment on a high-quality, vintage or collectible guitar: for that, it's always best to go and see a good luthier. But on a cheap old plunker or a laminated import, have a go at it!



INLAYS WORKSHOP

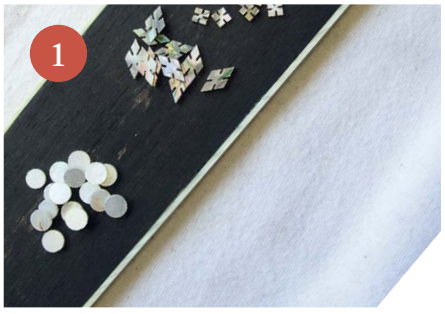
BLING IT ON HOME

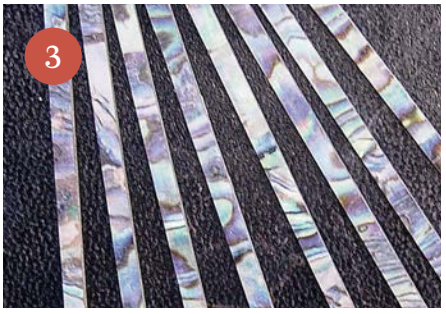
Pearl! It's the touch of glamour that makes a really classy guitar complete. **DAVE KING** has some insider's tips on how to shape some showy shell...

At our repair shop we often get requests to personalise people's instruments, which can involve anything from complete rebuilds to new fret markers. Here, we're going to take a look at what can be done with different inlays.

Fretboard markers, side dots and all other decorative inlays come in many different shapes, sizes 1 and materials: mother of pearl in black, white and gold 2, abalone in various reds and greens, and alternative materials such as malachite and lapis lazuli.

There's also AbaLam 3, a material invented by Chuck Erickson (aka The Duke Of Pearl) that helps conserve our existing stocks of shell. It's made from abalone and mother of pearl shells that are not thick enough to cut solid blanks from. Very thin slices are cut from the outside of the curved shells, epoxy is applied between the layers and then they are pressed flat. Because the slices are so thin they can be flattened without breaking and made into many different sized sheets of varying thicknesses. AbaLam does have its critics, though: you can go into the layers of epoxy when sanding, which doesn't polish to the same finish as the shell and can look unsightly. Still, with care this can be avoided, and you'll have the advantage of being able to cut far larger inlay pieces at once (it's available in sheet sizes up to 200mm square). It's also available in strips for purfling, which saves a vast amount of time. Normally solid shell would have to be cut by hand to go around the outside of a guitar, but AbaLam can simply be broken into the purfling channel and filled with glue, and >

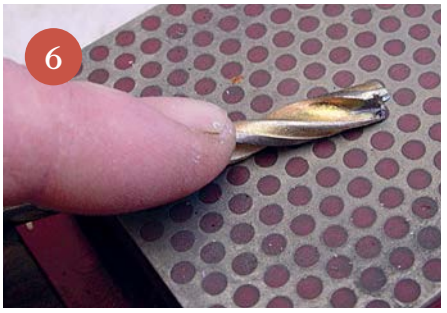




1 Pre-cut inlays Dots, stars and flakes can all be bought

2 Pearl comes in many shades, as do minerals

3 AbaLam Aka laminated abalone. Very convenient indeed



4 AbaLam on a Dave King guitar The results are impressive

5 The emulsion trick Makes marking out so much easier

6 Drill bit mods. Taking a 1/4" (6.35mm) bit down to 6.1mm

the when it's finished the breaks are almost impossible to see **4**.

Many vintage guitars have no fretboard markers or side dots – or both have fallen out. We'll have a look at fitting fretboard markers first. Before you start drilling holes, decide which positions you're going to put them in. On guitars you'll have a choice of the 3rd, 5th, 7th, 9th, 12th, 15th, 17th, 19th, 21st and 24th frets (if you have one). These are all the harmonics on a guitar string (though mandolins have one at the 10th rather than the 9th). I'm using a new fretboard here, but the same principles will apply to retro-fitting.

Whenever I'm fitting inlays I always start by painting the surface of the board with white emulsion **5** for visibility's sake as it's just about impossible to draw anything on a piece of ebony that you can see. Let the emulsion dry and then start to mark out. Importantly, check twice . It's not uncommon for certain guitar makers (myself) to be up until three in the morning before a guitar show putting an intricate design between the 2nd and 3rd fret to cover a hole that has been drilled in the wrong place!

Now we'll scribe the centre of the hole to give the centre-point drill bit a good start. The most common size of fret marker is either 6mm or quarter-inch (6.35mm). The problem is that a 6mm dot will not easily go into a hole produced by a 6mm centre-point drill bit – there needs to be some clearance. In time the fretboard might well shrink a little due to climate change or incorrectly dried timber, but the dots will not. This can result in the fretboard splitting along its length between the markers (more so on larger inlays). To overcome this I use either a quarter-inch bit with the edges very carefully ground off using an oil stone to reduce the cutting circle to about 6.1mm **6**, or first drill the holes with a 6mm centre-bit then use a 6.1mm metal drill to take out the clearance. For quarter-inch holes you'd need to use the closest metric metal drill (6.3mm).

AbaLam is a material made from abalone and mother of pearl that is available in time saving strips and sheets

I'm working on new fretboards here so I'm able to use a pillar drill with the depth-stop set correctly to ensure the markers go in level with the board. If you're putting markers into a completed guitar you'll have to use a hand drill, so here I always use a piece of dowel with a hole drilled through it to act as a depth stop **8**. For glue I use epoxy resin mixed with dust from the timber that I'm inlaying to ensure that any

7 Drilling the holes Double-check and triple-check first...

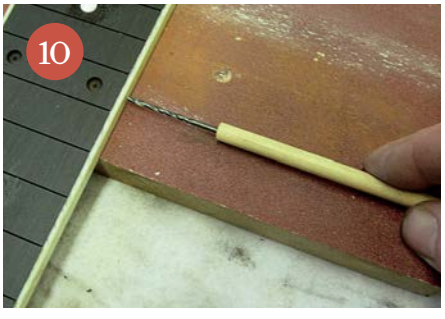
8 Depth stop. A homemade device for hand drills

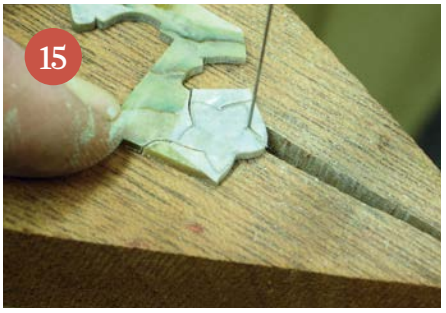
9 Colour match Adding wood dust to the mixed epoxy glue

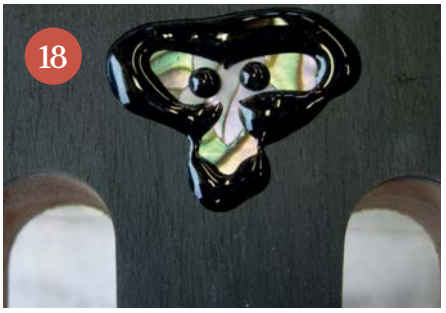
10 Side dots. Improvised hand drill reaches the tricky places

11 Jeweller's saw. This is the tool for cutting pearl inlays

12 Ready to cut. Shape is scribed in white paint on the pearl







gaps will not be visible 9. Araldite gives a little, which will allow for expansion and contraction. Make sure the epoxy is mixed well before you start to add in the dust; put enough glue in the hole to allow for some squeeze-out around the edges, and leave it to dry before sanding down. If you're planning to install side dots 10, mark them all out very carefully and scribe the centre of the hole. A hand drill is too big for this job, so I've made up a piece of dowel with the correct size drill bit glued into the end. With this you'll also be able to get to the fretboard past the body join.

While that's all drying we can try cutting some of our own shell. Shell is very brittle and needs to be cut with the correct tool: a jeweller's piercing saw 11.

The more teeth per inch, the finer the cut: saw grades for shell would generally be from size 1/0 to 3/0, or 48 to 56 teeth per inch. I generally use a 2/0 – small enough to turn a sharp radius corner, but not so fine as to snap all the time. You'll need a drawing of whatever you're going to cut (a few minutes on the web will find many patterns). Right now I need to put a triangular inlay just in front of a nut, so I'll scribe the shape on the white-painted shell 12 and then set to work with a supporting rest that I've made out of a scrap timber (the slot will become worn, so make a new one from time to time). I also have a vacuum attached to the support rest 15: shell dust is carcinogenic – so it's very important to wear a face mask as well. Hold the shell firmly and always cut on the downstroke; with practice you'll soon realise simple shapes are not difficult. Straight-sided pieces like my triangle are hard to cut accurately, but easy to clean up with a sanding stick 13.

For my headstock logo I've glued a paper template to the shell blank with a little superglue. When cutting shapes, try and cut into the corners from both directions to avoid radiuses where you turn the saw around; uneven sides can be cleaned up later with a fine file. I now have three pieces I need to glue together before inlaying. A non-stick frying pan provides a good surface 16; superglue doesn't stick to Teflon. Lay the pieces on the pan's surface and run glue run into the joints. Now the logo is in one piece I can lay it on my headstock and scribe around it.

I cut out my first-ever Tree Of Life entirely with chisels and a scalpel because I wasn't aware of Dremels 17, which – along with the inlay cutters from Stew-Mac – are the perfect tool for inlaying. When using any hand-held router remember to always push against the direction of the cutter, so if you're looking from above the router with the cutter going clockwise and cutting with the left edge of the cutter you would be pushing away from you; if cutting with the right hand edge of the cutter you'd pulling towards you. Remember not to make the recess too tight. The inlay should fall in: too tight and you run the risk of cracking the fretboard. Glue your inlays in the same way as the dots 18, using plenty of glue and once dry they can be sanded down flush with the surface. It's fiddly work but it all can be done with just a few simple tools. If done carefully with patience you'll be surprised at the quality of the results that can be achieved.

For shell supplies in the UK, try www.smallwonder-music.co.uk, 01435 830 509. Other places of interest based in the USA include www.stewmac.com, www.luthiersupply.com, and www.robinsoninlays.com

13 Straight edges. Easy to finish off with a sanding stick

14 Scribing the triangle. Note the full-sized handheld router

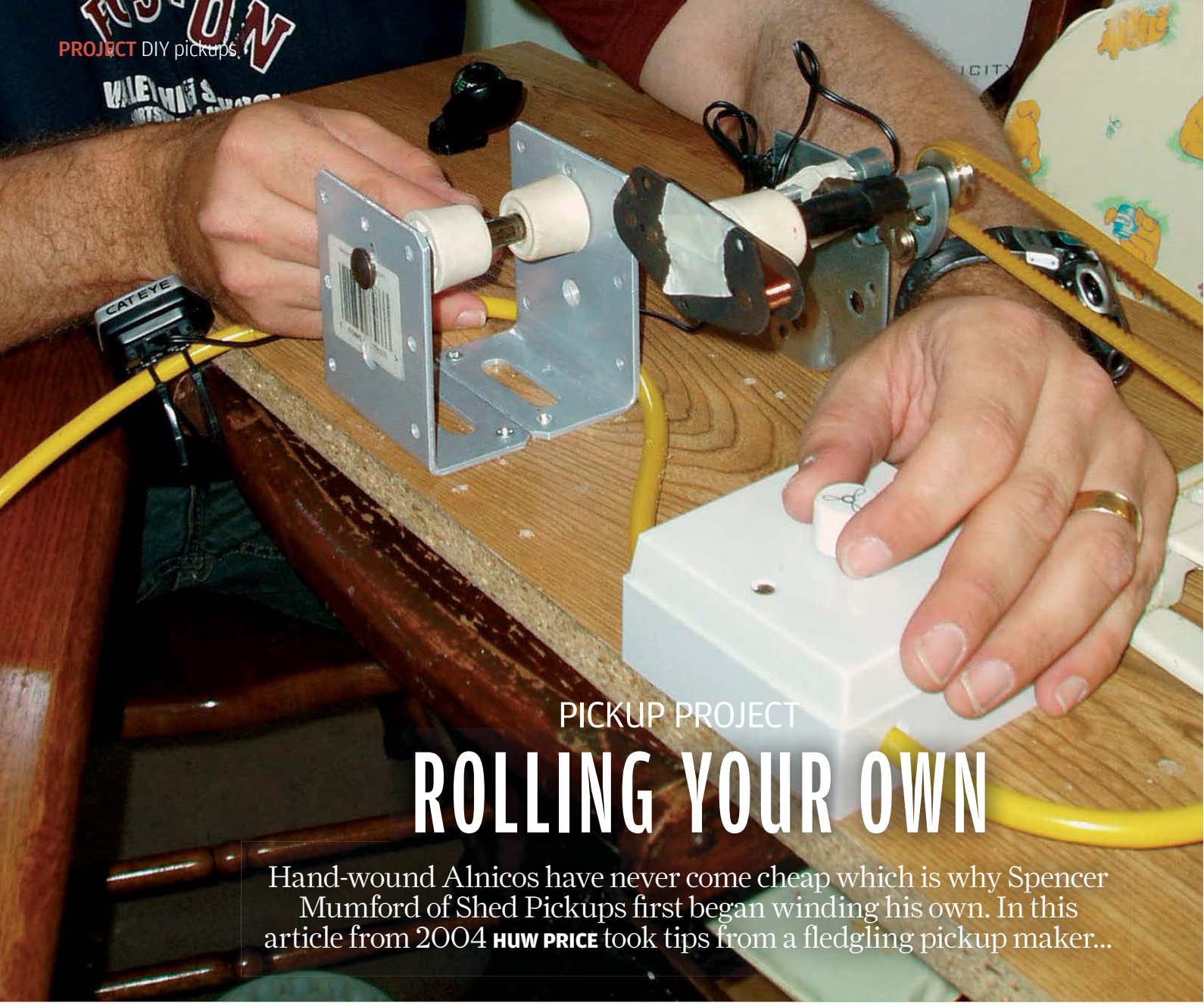
15 Cutting jig. Fragile pearl needs this supporting rest

16 The frying pan method. Best be stealthy with this one

17 Ready for the Dremel. Shape is marked out on the head

18 Gluing the inlay in. Nothing wrong with plenty of glue

19 All finished All dry, and sanded down to a fine finish



PICKUP PROJECT

ROLLING YOUR OWN

Hand-wound Alnicos have never come cheap which is why Spencer Mumford of Shed Pickups first began winding his own. In this article from 2004 **HUW PRICE** took tips from a fledgling pickup maker...

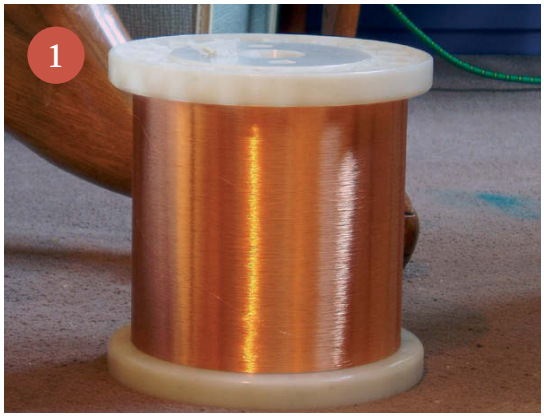
As a callow youth I once tried to wind my own pickup. I bought some magnet wire (God only knows what gauge), stripped the broken coil off a 1970s Strat pickup with a razor blade, and started wrapping. I had read somewhere that pre-CBS pickups had 8350 turns of wire compared to 7600 on later models, and I was also aware that they were 'hand wound'. Unfortunately I took that literally, so there I was wrapping the wire: one, two, three... it took me about a fortnight. Eventually the coil was so massive that I couldn't fit the cover on, and inevitably, it didn't even work.

Fast forward 20 years, and I'm reviewing pickups for Guitar magazine. When talking to manufacturers such as Fralin, Experience and Bare Knuckles, certain key phrases keep cropping up; 'scatter-winding', 'alnico slugs' and 'vulcanised fibreboard flats'. It seems that many sound-hounds believe that pickups from the 1950s and 1960s still set the tone, but through careful analysis of the materials used and the construction methods employed, today's pickup gurus believe it is possible to replicate the sonic characteristics of vintage pickups.

Why Handmade Pickups Sound Different

The standard industrial magnets of the era were made from an alloy of aluminium, nickel and cobalt called alnico that comes in various forms, all with different magnetic characteristics. Alnico V is the most common but some manufacturers are recreating the sounds of the early 1950s using weaker alnico II and III (rumour has it that the best-sounding PAF humbuckers were loaded with alnico IV). As usual it all came down to economics, and as alnico became increasingly expensive, manufacturers started using much cheaper ceramic magnets. Sound quality is influenced by magnetic strength, and since ceramic polepieces (slugs) are stronger than alnicos, they produce a brighter, more edgy sound.

Major manufacturers always seek to maximise efficiency, and by the mid '60s Fender and Gibson had decided that it would be cheaper to machine-wind their pickups. This produces an even coil that looks very neat – but it is thought to have sonic drawbacks. Hand-wound pickups are actually machine-wound, but the wire is guided onto the bobbin by hand. This introduces more irregularity into the wind, which – according to Lindy Fralin – results in a looser coil with more air gaps. You need a good grasp of flux



1 It's a wrap A spool of magnet wire, ready to go

2 Paraffin wax Yucky stuff, but good for potting

lines, capacitance and inductance to fully understand this phenomenon, but the bottom line is that hand-wound – or 'scatter-wound' – pickups are transparent and clear, but never brittle or edgy.

Materials

Most of the bits and pieces that you need to build pickups are easy to acquire. Allparts (0845 345 5951) sell vulcanised fibreboard pickup 'flats' for P and J basses, T-style and S-style pickups as well as all the stuff for humbuckers. You can buy small quantities of magnet wire **1** from Scientific Wire (020 8505 0002). What gauge? Well, AWG 42 (American Wire Gauge) was standard for Gibson and Fender, although some early Teles were wound with AWG 43, and Gretsch's DeArmonds used AWG 44. Allparts will supply Fender-style cloth covered or PAF-style braided lead-out wire.

Magnetic slugs are more of a problem; they are obtainable, it's simply that industrial suppliers have minimum orders. Eclipse Magnets (0114 225 0600) can supply alnico V and will cut it to length, but make sure you ask for the slugs to be pre-magnetised. Their minimum order is £50, so you could be making pickups for your friends, and their friends, too. Magdev in Swindon (01793 425600) offers a wider range of alnico rods for single-coils and blocks for humbuckers, and their minimum order is £23.50. Finally, you need to buy some paraffin wax **2** from your local hardware shop for potting purposes – your pickup kit is now complete.

The Infernal Machine

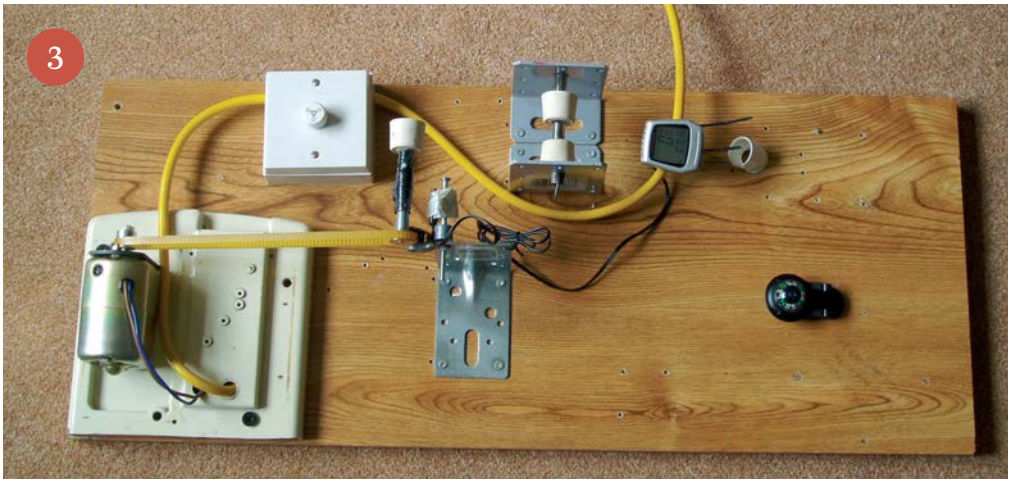
DIY pickup builder Spencer Mumford has figured out how to build a winding machine from commonly available parts **3**. First off you'll need an electric motor; like many DIY pickup builders Spencer chose one from a sewing machine. Because he planned to build the machine on a plank of chipboard, he took an angle grinder to the sewing machine to make a solid metal base for mounting the motor, but you could screw the motor down if you were using a solid wood base. He used the original sewing machine drive belt and attached this to the spindle that was used for winding cotton bobbins. This was mounted on an 'L'-shaped bracket and a 10mm shaft was pushed over the end that is used to mount the bobbin for winding. A little further back Spencer arranged two more 'L' brackets facing each other with a second 10mm tube fixed between them. In the photo you can see that two rubber doorstops have been drilled through and pushed over the tube. The wire passes between these, and the gap between them can be adjusted to stop the wire going over the edge of the bobbin.

Next: speed control. At first Spencer tried using the sewing machine's foot pedal but that wasn't sensitive enough, so he ended up using an electric fan controller from B&Q (a dimmer switch might burn out). The black insulation tape around the pickup mounting spindle holds a small magnet, and next to this you can see the magnetic sensor unit for an ordinary digital speedometer that Spencer bought from his local bike shop. The speedo is attached to the yellow mains cable just behind the wire guide, and Spencer uses this to gauge the number of turns – 19km equates to a DC resistance of 7K. The wire spool sits on the floor underneath the winding machine and passes up through a 90 degree elbow bend purchased from B&Q's plumbing section.

Last but not least is a car compass, which Spencer uses to check the polarity of his polepieces.

A Bit Of A Wind Up

Allparts' fibreboard pickup flats come ready-pierced with slug holes that are a little too narrow. **4** A 5mm drill bit is used to widen them, and after checking for >



3 The infernal machine Spencer Mumford's homemade winding rig, based on a sewing machine

4 Adapting the flats Drilling out the holes to 5mm

5 Polarity check. A car magnet will do just fine

6 Hammering in the slugs, gently does it

polarity **5** the slugs are gently tapped into the base ('north up' for Strat-style pickups) using a resin hammer. Vintage Fender pickup slugs were bevelled around their upper edges, but slugs direct from a magnet supplier have squared edges. If you want the rounded 'vintage' look, secure a slug in an electric drill, set the drill to maximum speed and gently touch the edge of the polepiece against a fairly smooth file and round over the edges. You might prefer to secure the drill in a workbench and hold the file by hand.

If you're making a 'staggered' set, make sure the slugs go into the correct holes and tap on the upper flat **6**. Spencer does his by eye, judging the slug height by placing a cover over the unwound pickup, but many people use spacers each side of the slugs. As a guide, the 'B' string pole should be just below the top surface of the plastic cover.

The next step is to lacquer the slugs between the flats to stop the coil shorting out. Nail varnish is ideal; colour is optional. Once dry, a 2mm bolt is passed from the base through the centre hole in the flats **7** (you might need to drill this one out a little, too). This passes through an un-drilled doorstop and a washer and nut is used to centre **8** and secure the bobbin before it is pushed over the 10mm shaft attached to the cotton bobbin shaft.

Spencer then starts the motor to see how square the bobbin is to the shaft, and makes fine adjustments to minimise wobble. The 42-gauge wire is fed through the plumbing pipe, threaded through the eyelet in the bottom flat and secured with a small piece of masking tape on the base of the pickup. More masking tape is used to cover the two metal eyelets to prevent the delicate wire snagging on them and snapping.

After setting the spacer rubbers, the first few turns are made by hand before engaging the motor. Spencer allows the wire to pass between his finger and thumb, holding the wire downwards so that it passes over the spacer spindle. Some pickup winders prefer to use felt to tension the wire and Spencer reports that the Fuzzy Felt shorts from his son's Noddy set works well, but he prefers to pinch the wire gently between his fingers. If the wire starts to feel hot, it means the tension is too great and you should allow the wire to move more freely.

Start with the motor running fairly slowly and build up speed as you become more confident. It's easy to see the wire as it passes onto the bobbin, and the tensioning hand is also used to guide the wire slowly and evenly side to side to side, carefully building up the layers gradually.

Although Spencer uses a kilometre gauge to regulate his windings, it's possible to buy counters to accurately track the number of turns. Some manufacturers check the DC resistance several times towards the end of a wind by carefully removing some of the magnet wire insulation and measuring using a multimeter; digital ones are best. If more turns are required, some lacquer is sprayed on to restore the insulation.

When you have finished winding, the loose wire is cut, threaded through the second eyelet and secured with masking tape, and then the wound pickup is removed from the spindle. Some manufacturers prefer to thread the loose ends of the magnet wire several times and even tie a knot to secure them.

Now the doorstop and bolt are removed, and after the ends of the cloth-covered lead-out wires have been pre-tinned they are inserted into the two eyelets and soldered. Scientific Wire's magnet wire is solderable so you don't need to strip the insulation layer off first, but remember to use a small soldering

7 Centre bolt. A 2mm bolt holds the flats together

8 Ready to roll The completed bobbin is mounted to the electric motor and carefully centre

9 Tele-style pickup ready for baseplate gluing

10 First try Huw Price attempts the task himself

iron tip – and it's best to work quickly, because the magnet wire can burn through.

Once the solder has cooled, check the DC resistance of the pickup with a multimeter; again, a good digital one is best. If you are getting no reading at all, try a little more heat on the solder joints to make sure the insulation has melted off. Once you have confirmed a satisfactory DC resistance, trim the ends of the wires under the bottom flat and push the other ends through the small hole between the eyelets.

Potty Time

Of course you want your pickups to wail, but you don't want them to squeal. Microphonic feedback is a nasty thing, and it occurs when the coils in a pickup start to vibrate from sound pressure. It is common practice to wax pot pickups, to solidify and protect the coil.

There is much debate about this practice and some claim that a properly-wound coil shouldn't need potting, but this requires correct and consistent tension – something only the best pickup makers can achieve. Slight microphony might even be desirable because the pickup will be more sensitive to the acoustic properties of the instrument, but this can get you into trouble if you use distortion pedals or high-gain amps. Seymour Duncan Antiquity PAFs are unpotted, like Gibson's 1950s originals and their current Burstbuckers, so you could try your pickups unpotted to see if you experience problems or not.

Potting is very simple. Pour some water into the bottom of a saucepan and place a Pyrex glass bowl into the saucepan, making sure it doesn't touch the bottom of the pan. Put paraffin wax into the bowl 12 (some people like to add 20 per cent beeswax), bring the water to the boil over a low flame and the wax will quickly melt. Paraffin wax is flammable, so be sure to keep a fire extinguisher handy. Turn off the heat and submerge the pickup and the cloth-covered wires 13. You should see tiny air bubbles escaping from the sides of the coil and from the ends of the slugs.

After a minute or two this will stop and the pickup can be placed on a non-stick surface to cool (according to Spencer, the cover of Guitar is perfect). Check you still have a DC reading and pop your new pickup into your guitar.

It's A Wrap

After watching Spencer wind a T-style bridge pickup he suggested that I try making myself one for my Strat. Barring one scary moment that required some expert untangling, I successfully completed my first pickup and I couldn't wait to get it into my guitar. I'm chuffed because it sounds very good. The highs are sweet and clear, the bass is well defined and it doesn't squeal.

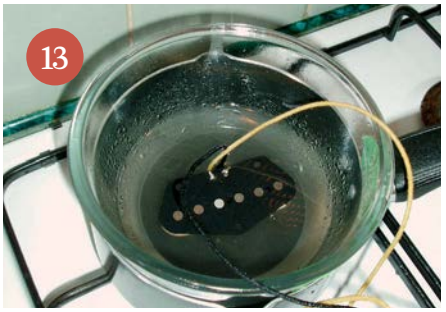
Spencer estimates that single coil pickups cost around £12 to make, and humbuckers will set you back around £20. When you consider that a winding machine will cost you around £50 to put together and that the cheapest off-the-shelf hand-wound pickup will set you back around £70, rolling your own seems like it could be a good way to go. If you have a Strat, for example, you could wind a hot set for rock gigs and a 'vintage' set for blues, country or funk – just mount them on two separate scratchplates and swap them as required. If they sound really good, you could even start making them for your mates...

Since this article was first published in 2004 Spencer Mumford has become a highly respected boutique pickup maker and his Shed Pickups are now widely used by many top players. Go to www.shed pickups.com to see how he's progressed

11 Dying the wire Vintage look for cloth-cover wire

12 Melting the paraffin Technically, a 'Bain Marie'

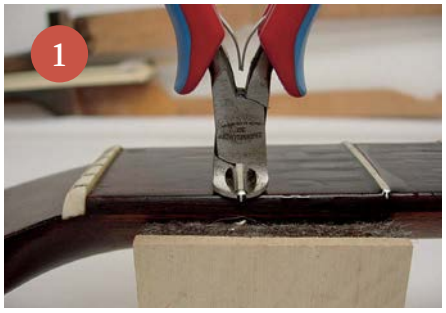
13 Potting the pickup Soaking the completed unit in wax helps prevent microphonic feedback

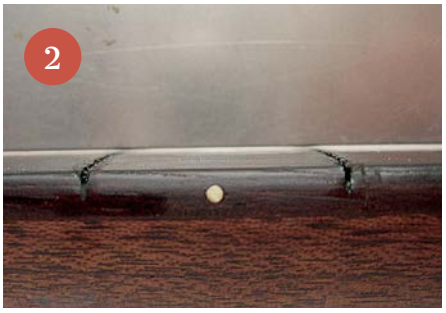


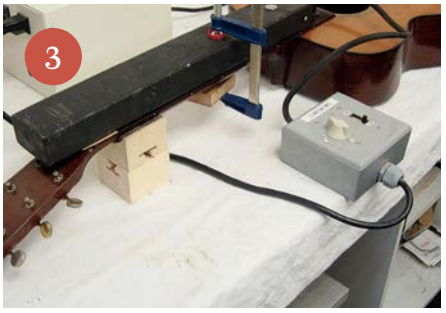
DIY WORKSHOP

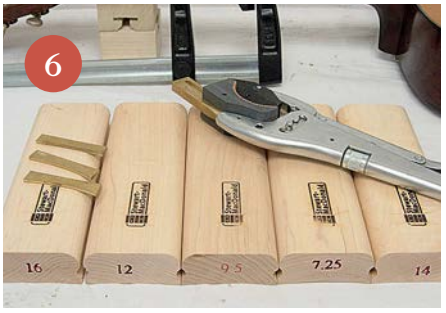
PROFESSIONAL TOUCH

Most of our workshops have looked at repairs and set-ups you can do at home with tools available on the high street. **DAVE KING** looks at a couple of specialist gizmos that could take your luthiery to new levels...









Specialist tools can make your life easier and a lot more efficient. The purpose of this feature is to introduce you to a few that have become really indispensable for me..

Our repair subject is a Martin 000-18. It's a guitar that's had a hard life. The neck is bent and is in need of straightening, which will help get the action down a little, and the frets are worn out and all need replacing: Generally, this guitar is in need of a little love and care.

The first tool we're going to have a look at is a pair of fret-pullers 1 from Stewart McDonalds in the USA. For years I've been using pincers with the face ground off to give a flush surface to get under the frets, but this tool is purpose-made for the job and will pull the frets out quickly and efficiently. One tip: soak the fretboard with lemon oil 2 before pulling the frets, as this will help stop the tangs of the fretwire breaking out the surface of the wood.

Once the frets are out, a close inspection of the board reveals a concave gap under the straight-edge, which means a bent-forward neck. Many old instruments like this Martin have no adjustable truss rods, and the fretboards are generally not thick enough to allow us to simply plane them flat, so we need to try and flatten them some other way.

A neck heater from Luthiers Mercantile International (again from the US) makes this a very simple job. As you can see from the picture 3, it's a hollow, flat steel bar with a heating element inside that can be heated up to about 250 degrees centigrade, though to straighten our neck we'll only need a temperature of 100 degrees. The crucial point here – in italics, just to make sure you don't miss it – is don't get it too hot! I'm using a multimeter to measure the temperature 4, but it's much cheaper to buy a surface thermometer from one of the luthier suppliers. Any more heat than this and you could well pull the fretboard off rather than just soften the glue.

I've clamped the element to the fretboard with a packer under one end 5; this way, when it gets up to temperature, the glue joint between the fretboard and the neck will soften, and this in turn will allow the neck to be pulled back, getting rid of the bow. The heater will need to be left on for about an hour to soften the glue sufficiently; once the glue has softened and the neck has moved, the heater needs to be turned off and left to cool, giving time for the glue to harden. I leave it all in the clamps for a further 24 hours, just to make sure.

Next, fretboard tools 6. We do have quality retailers in the UK, such as David Dykes Luthier Supplies (01435 812315) and Touchstone Tonewoods (01737 221064), but the specialist tools we're talking about here are only available direct from the US, >

1 **Fret-pullers for removing worn-out frets**

2 **A dab of lemon oil will prevent chipping the board**

3 **A Neck heater for straightening non-adjustable necks, or even correcting back-bow. A dangerous item: use with care**

4 **This multimeter checks the temperature stays around 100 degrees**

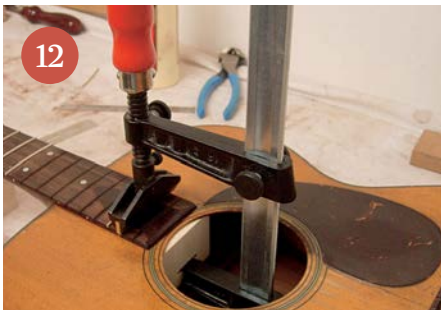
5 **A packing piece that is just the right depth to get rid of the bow**

6 **These neck tools will speed up neck jobs considerably**

7 **Sanding blocks carved to exact radii for fingerboards**

8 **A fret slot saw that cuts on the 'pull'. Comes complete with depth stop**

9 **The Jaws is brilliant hand-held fret press. No more hammers!**



10 The Jaws 2 is another Fret Press. This one combines the fret caul with a big F clamp to give access to the upper fingerboard. Packing bits are included

11 Packing blocks A bit of improvisation around the octave

12 Upper frets Jaws 2 also works through the soundhole

and all these come from Stewart MacDonald's (www.stewmac.com). You'll see from the picture that I have a selection of profiled sanding blocks to help me clean up the fretboard **7**. These blocks will produce the correct radius on the fretboard, which will later tie up with the fretting tools. Remember, many modern instruments have a compound radius which gets shallower the further down the fretboard you go, and for these you won't be able to use the sanding blocks: thankfully, the old Martin we have on the bench this month has the same radius all the way down the fretboard. I've used a 12" radius block with 180-grit glasspaper stuck to it, and you can go on to 320 grit to get a mirror finish. You won't always get all of the wear marks out, so remove just enough to give the frets a flat surface to seat on.

Once the fretboard is levelled you'll need to clean out the fret slots, and possibly make them a tad deeper. Another specialist tool is a fret slot saw **8**. You can now get one that has a stop on it, which can be adjusted to the correct depth to ensure you don't go too deep. It also cuts on the 'pull' stroke. Most Japanese tools work in this way – it allows the blade of the saw to be thinner, and that makes a finer cut.

Now we can move onto the fretting tools. For many years, the idea of banging frets in with a hammer on an instrument that you may have spent many hours working on or may be very old and fragile has seemed to me to be rather barbaric! No more: with modern tools you no longer have to do this. The first tool I'm going to be using is the Jaws hand-held fret press **9**. This one comes with a selection of clamping cauls to suit the radii blocks we used earlier. With the 12" caul fitted to match the sanding block we used, the fret press simply slips over the neck and fret and a gentle squeeze on the handle pushes the fret in evenly all the way across the fretboard. With the Jaws and the second fretting tool I'll mention you can very quickly work your way from the first fret up to the heel on an acoustic guitar in about 20 minutes. One of the big advantages of this system is that it will push all the frets in to the same depth; hammering them in never seems to get them all perfect, though I'm sure some might argue. Nevertheless, with this system the frets don't even need levelling when finished – just a quick polish.

Once we've got up to the 10th fret the Jaws press will not work because of the shape of the heel, so we'll move on to the next fretting tool: the Jaws 2 **10**, complete with cauls. This is a standard F clamp modified to accept the clamping caul that we used earlier and it also comes with a selection of clamping blocks to sit over the braces on the inside of the guitar. Packers **11** can be made to work your past the 10th to 14th fret, making a bridge between heel and neck, and by using this we can now press the frets in from the neck join to the top of the fretboard.

The two or three frets at the end are always a problem as there's not a lot underneath holding them up; when hammering, the hammer tends to bounce on the fret! It's possible to put sandbags and various other things inside the guitar to absorb some of vibration, but in my experience pressing them is by far the best method. You can see from the pictures **12** & **13** that the last fret has just been done, and this one has always given me the most problems in the past.

So here we are, with all the frets installed, levelled and correctly seated, and with less risk to a nice guitar than with the tools we used to use. All of these are great devices that can help make doing our repairs that much easier!

13 Caul close-up Concave, and curved to press the frets in

14 Finished job One Martin fretboard ready for another 50 years

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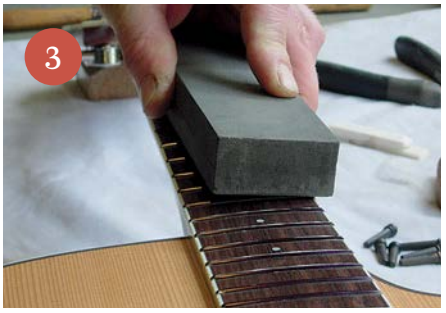
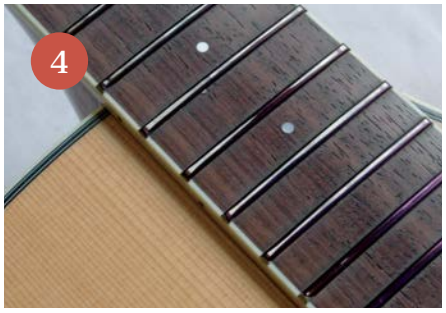
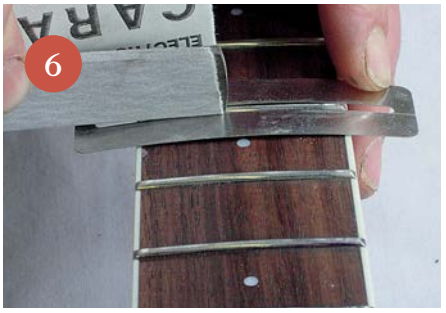
DIY WORKSHOP

BOOST YOUR SPRUCE

With a little knowledge, a few tools and the odd chunk of cow's tibia, a Chinese or Korean acoustic can be made to sound darn good and play surprisingly well. Top luthier **DAVE KING** leads us through the process...





Our guinea pig guitar for this 'DIY acoustic upgrade' feature is a Cort SFX. For around £300 it's a lot of guitar, with solid spruce top and mahogany back and sides, but there are a number of things we can do to improve the spec. While our Cort is good value, it has a plastic nut and saddle which don't transmit the sound as well as bone. The neck needs a little adjustment and the frets could really do with levelling and re-profiling. The bridge pins are also plastic, and we'll replace them with ebony ones.

The best place to start is by removing the old nut 1. This will be glued in, so be careful; place a block of wood behind it, and gently tap it with a hammer. Once it's safely removed, we can start to level out the frets. First, adjust the truss rod so that the neck is straight (here the adjusting nut is inside the guitar at the neck join, but if there's a cover plate on the headstock on your guitar, it will be under that). Make small adjustments, no more than a quarter turn, and use a straightedge to make sure the fretboard is as close to level as you can get it 2.

Now we'll need a new, flat oilstone to level the frets, and check it's flat with a straight edge: if it's not it can be levelled on a piece of plate glass using wet and dry paper. Don't just whizz all the way up and down the fretboard, as that way you'll just follow the frets and not eliminate any high spots. Instead, work backwards and forwards a few inches at a time 3. Remember to tilt the oilstone over to the left and the right, and keep checking everything carefully. You should end up with a thin oilstoned line visible across the top of all the frets.

Now the frets are level we can begin to profile them. We'll work first on the fret ends 5. I use a small triangular needle file with the corners ground off, which stops the file from marking the fretboard. For added security you can also use a fretboard protector (available from www.stewmac.com) 6. Hold the file at about 45 degrees to the end of the fret and gently radius the end of each one. Many top makers still use a triangular file to profile the frets, but this is very difficult; I'd advise you use one of the files designed for the job, with a hollow surface on the cutting edge (these come with quite a coarse surface, mind, so the best way to use them is to wrap a piece of glass paper around them 7, starting with 320 grit aluminum oxide paper then move up to 600 grit wet and dry). Once you've removed all of the marks made with the oilstone, the frets can be polished with 0000-grade wire wool. Use a little lemon oil at the same time 8, as this will clean and protect the fretboard.

Now the frets are all levelled and polished, we can start on the nut and the saddle. Is bone superior to plastic? Yes, in most cases bone will greatly enhance the sound of your guitar: I've tried most of the substitutes and in my opinion, none seem to work as well.

Let's begin with the nut. Place the blank in position and mark around the end of the board, and then mark a line across the top about 3mm higher than the fretboard (I know this seems a lot, but we'll reduce it later) 9. You can shape the nut in a number of ways: files, a grinding wheel, or the method I prefer, glass paper stuck to MDF sheets. Start on 80 grit then go up to 240. The marks left from the 240 will be polished out using 600 grit wet and dry when we've finished the nut. You'll need a bevel on the back of the nut and one on the top; the angle on the top needs to be about five degrees less than the angle of the headstock 10 (normally 15 degrees).

To file the sides of the nut, you'll need to hold it securely. I use a 50mm-square piece of timber with a rebate to hold the nut, and because the timber is 50mm square it gives you a surface to hold a sanding block or file against 11. The exact angle of the sides of the nut are usually square, but some guitars vary. Just make sure the nut is flush with the edges of the fretboard. If you try holding it just with your hands you'll end up with a rounded side to the nut... not a pro look.

Now's the time to move on to the saddle, the removable piece >

1 Removing the nut. No thwacking! Very gently does it

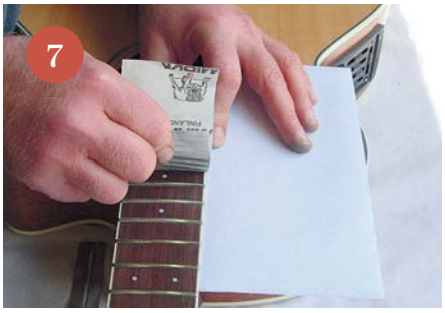
2 Make sure fingerboard is flat. Use a good straightedge

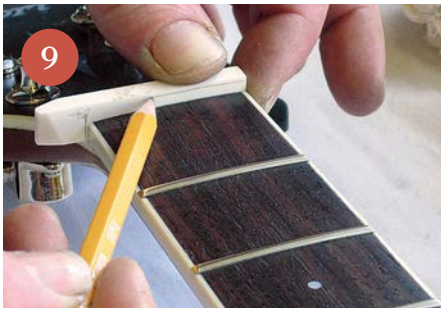
3 Levelling the frets. Work a small area at a time

4 Use a black felt-tip to show when all the frets are being touched

5 Rounding fret ends You can use a needle file, carefully

6 Fingerboard protector Natty gadget and a useful buy





7 Rounding fret tops Using a concave file with glasspaper

8 Lemon oil and fine steel wool Gives a lovely finish

9 Setting the initial nut height It'll come down later

sitting in the bridge. This Cort has a 'compensated' saddle, so the point at which the string leaves the surface of the saddle varies from string to string. Why? Well, when a string is plucked on any stringed instrument – at least, any fretted one: violins are exempt because you can change the tuning by moving your finger a fraction – there is a small amount of string at the point where it leaves the nut and the saddle where it does not vibrate, and this changes the tuning of each string, depending on the gauge and the tension. Compensated saddles make up for this by varying the string length to allow for the part that is not vibrating, making your guitar play a little more in tune. On electric guitars, of course, each string saddle is individually adjustable, but this would be very difficult to achieve on an acoustic guitar because of buzzes and rattles. Compensated saddles are harder to make than a straight saddle but they do ensure that your guitar plays a little more in tune, so if you're the sort of person who is bugged by the fact that an open E chord can be in tune at the bottom of the fretboard but out of tune at the top, then this will help.

If the old saddle is the correct size, simply copy the new one from it – but make it a little higher (about .75mm) to allow for the adjustments we'll need to make for the compensation. Start by making sure the bottom of the saddle is flat 12 (vital on all guitars but especially on electro-acoustics, where a bad contact with the pickup below will give an uneven response). Now, cut the new saddle to length, holding it in a vice or cutting block, making sure the ends are square. Sand the saddle down to thickness using your sanding blocks, making sure it's an even thickness along the entire length and, importantly, not too tight in the slot: it should be a gentle push-fit, but not fall out. Once happy with the length and the thickness 13 – especially round the ends of the saddle 14 – mark the profile from the old saddle, hold it in a vice and file to shape.

Now the tricky part... filing the top of the saddle for the compensation. First, make up a jig to hold it, using either a piece of timber or MDF with a 35 degree bevel cut on the face of it and a rebate in the opposite side to hold the saddle. When clamped to a work surface this will allow you to work on the saddle securely; the bevel will help you guide the file and the rebate will hold the saddle (if you're unsure, practice on a saddle-sized piece of timber first). Hold the new saddle next to the old one and transfer the centre points from the old to the new 15. You'll see the treble E is closest to the front and the B closest to the back. Put the saddle in the jig and start filing back to the correct points that you have marked 16, using the jig to guide the file. Once you've finished work on the front of the saddle, turn it over and file the back edge to suit,

10 Correct angle. You need to 'halve' the angle to the head

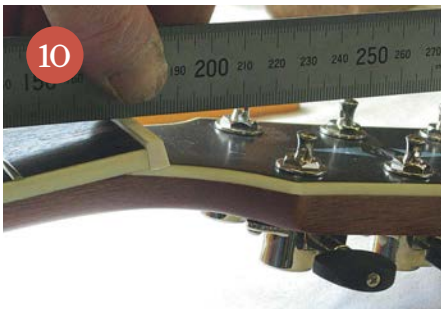
11 Filing the nut sides. Use a little jig to keep things square

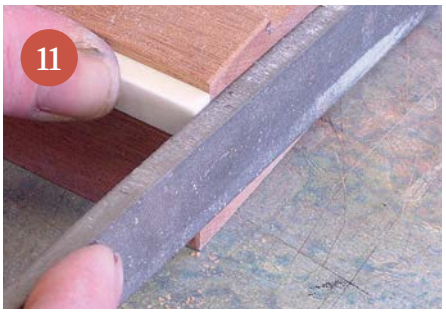
12 Filing the saddle bottom. This method will keep it totally flat

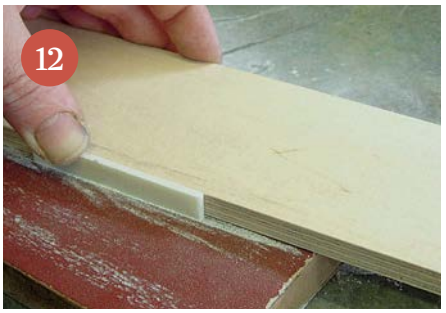
13 Saddle thickness. Don't take too much off the ends...

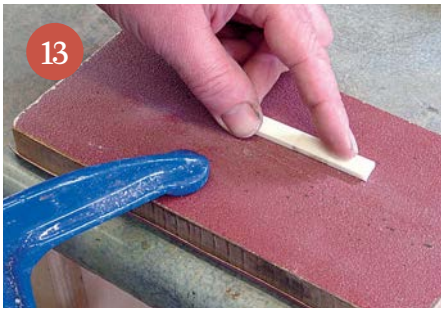
14 Round off the ends. For a perfect fit in the bridge slot

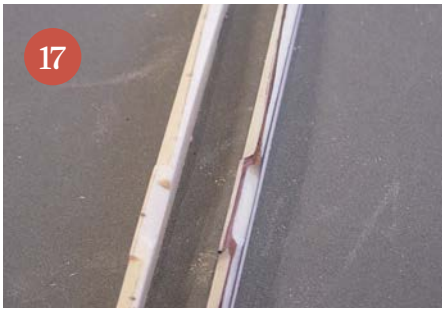
15 High points. Copy the compensation to the new blank

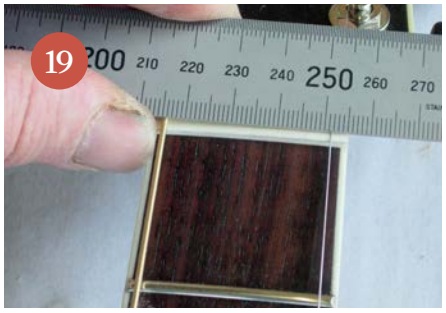


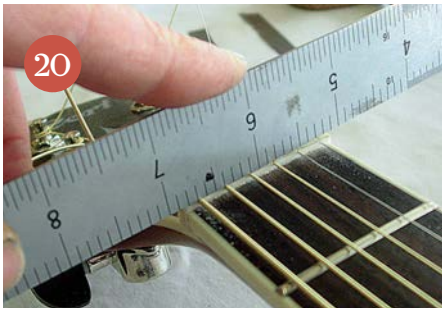












making sure that you've worked to a point about 0.5mm wide.

When you've completed all the 'steps' the top of the saddle can be rounded over to give the strings a smooth surface to sit on 17. Make sure there are no flats; the string needs a radiused point to travel over, and flats give buzzes. Finish the saddle with 320 grit to remove the file marks, then 600 grit to get a nice polish.

The only other thing we're going to is replace the string pegs. On this guitar they're plastic, but wood ones – we'll use ebony – will make sure that more sound from the string gets transmitted to the top. For this job you may need a reamer (expensive) 18 which will cut the holes for the pegs with a taper, ensuring a good fit. Ream the holes out until the pegs sit flush on the bridge. Make sure the reamer stays square to the guitar, and use a square for guidance.

Now it's time to fit the strings. Place the saddle in the bridge and rest the nut in position (don't glue it yet). Fit the two E strings first, aiming for about two and a half turns of string around the tuner. Tighten the strings up enough to keep them taut but not to pitch.

The best way to cut the slots in the nut is with proper nut files. The centres of the two E strings should be 3.5mm in from the edge of the fretboard 19. Cut the slots with the file at an angle halfway between fretboard and headstock, ensuring the string has contact all the way across the top of the nut. When the E strings are in the right place, add the rest of the strings and again tighten them up a little. There are many ways of spacing the strings equally, but if you just measure from centre to centre you'll end up with a smaller space between the bass strings than the treble strings. I generally divide the space equally then make smaller adjustments by eye... or carefully measure the space between the strings 20.

A reasonable action to aim for at the first fret would be a gap of about .5mm between the first fret and the underside of the string on the bass, slightly less on the treble. At the same time as lowering the strings at the nut you'll have to be checking the action at the 12th fret. This should be about 2mm under the bass side and 1.5mm at the treble. These figures are rough guides, and depending on your style of playing you may like to adjust them either way. Bring all the strings down evenly, a little at a time 21.

Now remove the strings, nut and saddle. The strings should sit with no more than half their depth in the nut, so reduce the top to suit and finish by polishing with 600 grit wet and dry. Put everything back together, and this time put a dab of glue under the nut. When the guitar is tuned to pitch, adjust the trussrod to leave a slight hollow in the face of the fretboard.

As it turns out, our humble Cort has been transformed. It's a far more playable guitar, with better tone, volume and sustain. The time spent replacing a few parts has been really worthwhile.

16 Filing the angles. Note the jig and, again, the felt-tip trick

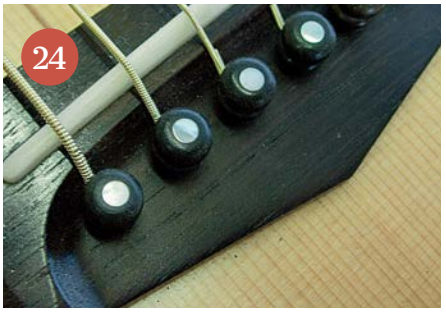
17 Compensation done. Just some rounding-over to do

18 Reaming for new pins. Tape on reamer marks max depth

19 Outside nut slots E strings should be 3.5mm from edge

20 Spacing the other slots. Take your time: this is vital

21 String heights. Take each one lower a tiny bit at a time



22 Slot angle. The correct angle ensures a buzz-free nut

23 Finished nut. Perfectly cut and beautifully polished

24 Saddle Like the original, but in toneful bone. Fine job!

RESONATOR WORKSHOP

PAIN IN THE NECK

Got an old resonator that's in need of a bit of TLC? Or maybe you just fancy finding out how these maverick guitars hang together? **DAVE KING** shows us how a pro tackles a neck set on a National...

In this article we're going to take a look at some maintenance work on a single-cone resonator guitar. After 70 or more years of coping with 160lbs of tension on the neck, it's inevitable that some vintage Nationals are suffering from neck angle problems. On a resonator guitar the angle of the strings over the cone determines the amount of downward pressure on the cone: too much and it'll kill the sound, too little and there won't be enough pressure to make the cone work..

The instrument that we're going to be looking at is suffering from too little downward pressure over the cone and displays an action at the 12th fret of 4.5mm, which too high even for slide playing (this instrument needs to be set up for fingerpicking rather than slide, so we need an action at the 12th fret of about 2.5mm. You can see from the picture 1 below that the straight-edge shows only a few degrees of string break angle over the cone, and we need an angle of about 15 degrees. Also, the bridge is far too low: we should have a saddle height of about 7mm-9mm. Any higher than this and the forward pressure on the cone will make it collapse. This an original, irreplaceable cone from 1934, so great care is needed – and these cones are only about eight thousandths of an inch thick.

This instrument needs to have its neck taken off and reset at a greater angle, which should give us the right action along with the correct saddle height and break angle. With the strings and cone removed, we can start dismantling it.

First, the soundposts 2. These hold the instrument together, and without them the guitar would collapse. They are generally glued and pinned in but unfortunately here the pins are pushed under the surface of the neck pole, so pulling them out is not an option. We need to get a saw into the sound well and cut them out, not forgetting to also remove the two screws that go through the sound well and into the neck pole.

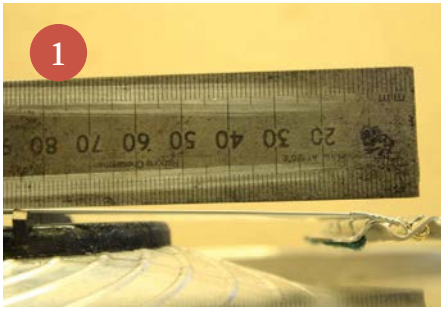
This is an irreplaceable original cone from 1934, and it's extremely thin, so we need to take great care

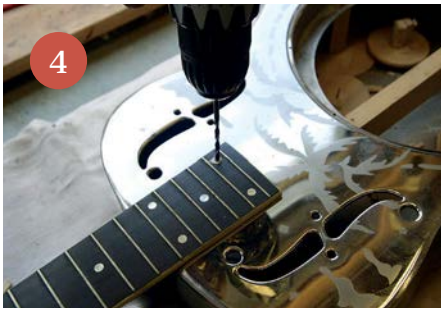
The end of the fretboard is screwed onto the metal body at the 15th, 17th and 19th frets – which is why there are two position dots at the 15th and 19th for a screw either side of the fretboard (the one at the 17th goes right through the body and into the neck pole). The screws are located underneath and they need to be carefully drilled out with a metal drill bit 4 (not a centre-point bit like you'd use on timber) which should be a couple of millimetres less than the diameter of the marker; this way we can drill through and prise the rest out. Don't drill too deep, just through the dots, or you'll end up drilling the head of the screw off 5.

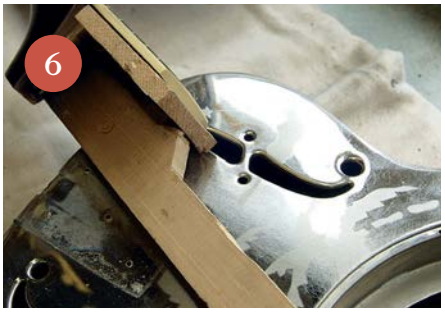
We can now see how the neck join works. The timber packer under the end of the fretboard goes between the neck pole and the body of the guitar: this pushes up on the inside of the guitar's top and ensures we end up with a flat fretboard rather than one that dips down over the neck join.

Before starting work on the neck angle I'm going to replace the saddle in the biscuit with a new, higher one made from boxwood – which is what the originals where made from. This will give me something to work to when I'm adjusting the neck angle. If you're careful, the old saddle can be levered or chiselled out and simply replaced: it's a good idea to keep the original biscuit as these instruments are far more collectable when original (and anyway, replacing it will change the sound).

Now, the neck angle. I'm going to remove some timber from the neck pole 6 to allow me to pull the neck back. Using a straight-edge, I've marked a line down the length of the neck pole: the straight-edge must be held at the heel of the neck as this is where the whole >







1 Shallow break angle does not produce enough downforce for the cone

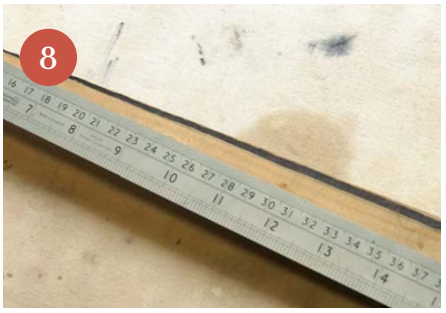
2 Removing the old soundposts. A saw is the only way

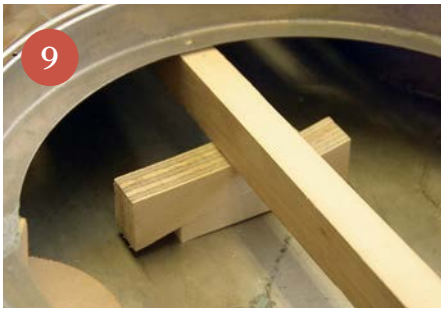
3 Removing neck post. First, the screws in the soundwell

4 Drilling out the pearl dots. What is this madness? Well...

5 The screws are hidden underneath and there are five in all

6 A timber packer goes between the neck pole and the top





7 New saddle Crafted from boxwood, like the original

8 A matter of angle Marking out a 'wedge' at the top of the neck pole. With this removed, the neck angle will be right

9 The folding wedge technique. Pushing these together shifts the neck pole up by tiny increments until it's just right

thing pivots from. This should result in a wedge being cut from the neck pole **8**.

With the material removed, we can put the neck back in and check the angle (make sure you put the packer back under the end of the fretboard). You can see from picture **9** that I've used a pair of folding wedges to push the neck pole up against the sound well; this will do until we've got the right neck angle, then some new soundposts will need to be cut.

The string angle controls the pressure on the cone: too little and it won't work properly

Picture **10** shows the neck fitted but we still don't have enough angle, so we'll have to take the neck back out and remove some more material from the neck pole to pull it back further. After the second try, all is well.

Still, before we can refit the soundposts and position markers, some work on the neck join is needed. Because we've pulled the neck back the heel no longer fits the body of the guitar **11**, and it needs to snuggle up perfectly. We'll cover the body of the guitar with tape for protection, then mark the joint. I have a number of different scribing tools for this job **12**: the one I'm using here is a ruler with a cutting edge ground on to it. With a line scribed all the way round the heel for me to work to **13**, I'll carefully chisel my way down to the line **14** and hopefully we should end up with a perfect fit without even the tiniest visible gap **15**.

With the neck correctly fitted we can get on with securing it using the soundposts and the screws under the fretboard markers. I've made some new props for the soundposts: that way we keep the original round 'biscuit' packers. To mark out the height I'll hold them about an inch in front of where they need to end up and mark a line across them using a Stanley blade as a scriber **16**. This makes them come out a little long, but by the time you've moved them into the correct position they should fit with just a light push. I've used a little glue on the top and some pins to hold them and I've also left the tops of the pins a little proud **17**, so if they need to be removed in the future they can just be pulled out without having to cut the soundpost.

The only other work we need to do to finish the inside of the guitar is to replace the two screws that connect the sound well with the neck pole. Also, there's a wedge between the end of the neck pole and the end block that needs to be fitted, glued and gently pushed into

10 Not enough. The saddle's the right height, but our first neck reset hasn't given enough angle. Time to try once again

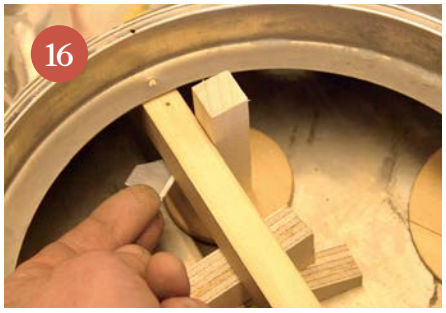
11 Heel gap The neck set means the heel has tilted away

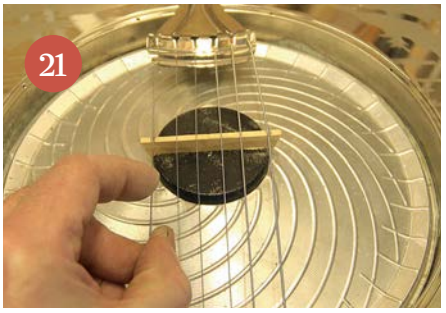
12 Homemade scriber. Dave uses a ground-down ruler

13 Marking the line Shows how much wood must come off

14 Chisel time. Carefully take the wood off down to the line

15 Heel re-fitted No visible gap. You'd hardly ever know...





place. We'll let the glue hold it and not force it in, as if it's too tight it could well push the neck away from the body.

Once the screws have been fitted to hold the end of the fretboard down we can install new pearl dots, running a little thin superglue down the sides to hold them securely 18, and when the glue is dry they can be filed down flush to the surface of the fretboard using a fine file 19. Check that the end of the fretboard is straight over the body join: if it needs pushing up then a small wedge can be pushed in between the neck pole and the packer on the inside of the guitar 20. This often can mean getting your hand into some pretty awkward places inside the guitar.

Now it's time to start cutting the string slots. You can do this in a number of different ways: one way is to mark out the string slots then remove the biscuit from the cone to cut the slots, but I prefer to cut them while the biscuit is still on the cone 21. Beware: if your files are not sharp and you catch one of them in the string slot, you run the risk of crushing the cone. On an original, irreplaceable cone this would be a catastrophe, so proceed with caution!

Beware: if your files are not sharp and you catch one of them in the string slot, you run the risk of crushing the cone.

Picture 23 shows the break angle and the height of the new biscuit, plus an action at the 12th fret of 2.5mm. Before we replace the coverplate, we need to clean up the top of the saddle. The slots in the saddle should be exactly the same depth as the strings – any deeper and you seriously run the risk of choking the sound, but if they're too shallow they will fall out. Some resonator players like to have the slots cut to a 'V' shape to ensure the strings don't choke, but I've always found cutting to the correct depth works perfectly fine. I've used a sanding block to sand down the top of the saddle and smeared the biscuit with wood glue to hold it securely on the cone. A little black stain always helps make it look a little more like it should.

When we place the cone back in the soundwell we'll make sure that the bass side of the saddle is about 2mm closer to the bottom of the guitar than the treble side to allow for intonation. All the remains are the tasks of replacing the cover plate and restringing. We now have a National resonator that should hopefully be fit for another 70 years of playing without making the owner's fingers too sore...

16 Marking new soundposts. Note the old round 'biscuits'

17 Pinning new soundpost. Pin left proud for future removal

18 New pearl dots. One job where superglue really works

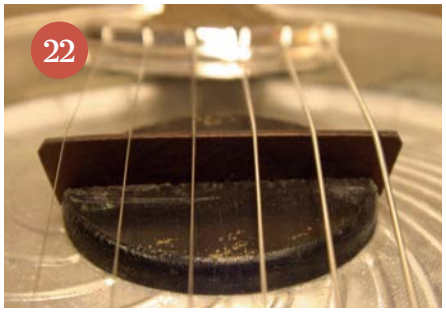
19 Filing down the dots. Careful not to mark the fingerboard

20 Checking the neck is straight. A wedge can be added

21 String slots. Dave does this with the saddle in place

22 Completed saddle. Correct depth slots, plus dark stain

23 Perfect angle. The new neck set has given a perfect 15 degrees of string break over the saddle. Bring on the blues!



NECK RESET WORKSHOP

TIME WOUNDS ALL HEELS

Many aging acoustics would benefit from a neck reset and some careful attention to the dovetail joint. In this article a Gibson J-45 gets the full treatment. **DAVE KING** is the man with the chisel...

The Gibson J-45 is a classic spruce/mahogany slope-shouldered guitar, and a mainstay of the company's range from 1942 until 1969. In the '70s the model went square-shouldered, but it made a strong comeback in the reissue era and has now regained its place as a classic fingerpicking, rhythm and songwriter's tool. Our patient is a fine example from 1950, with a problem that's likely on any guitar this old: the need for a neck reset..

Apart from the neck joint actually breaking, the only reason to reset a guitar's neck is to increase or decrease the neck angle. On an acoustic guitar the tension on the strings amounts to about 180lbs, and over time the tops can belly outwards or the neck can pull forwards, either of which will result in a very high playing action.

The easiest way to check whether a guitar needs a neck reset is to place a straight-edge along the fretboard 1 and see where it meets the bridge (with saddle removed). The straight-edge should just hit the top of the bridge 2. On ours, as you can see, it's pointing at a spot halfway down the bridge. If the bridge is higher than 6mm it's sometimes possible to simply plane a little off the top; bear in mind, though, that if the bridge is 9mm high and you plane 3mm from it, this will reduce the tension on the soundboard, and this can adversely affect the sound.

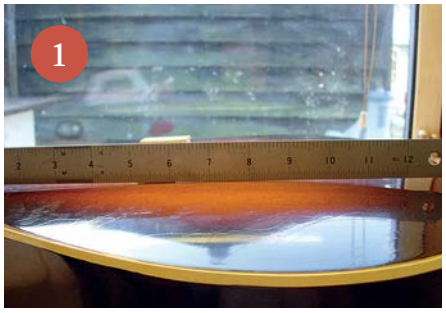
On this instrument we could do one of two things: either reset the neck at a different angle to compensate, or re-brace or replace the top. The problem with doing any work on the top is, again, that it might drastically change the sound of the instrument, and many vintage guitars sound as good as they do because of the way the tops have moved under tension over the years. There's also the question of value and originality. So, generally, the neck would be reset.

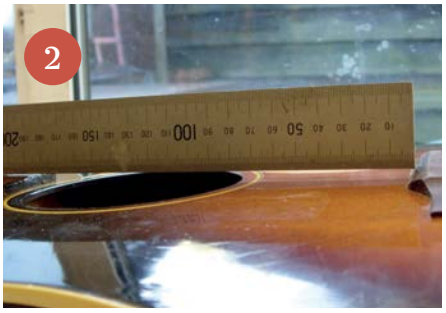
Extra care is needed with old Gibsons. On some, the necks were put into the sides before the top was glued on. This means that the top goes over the dovetail joint, so pulling the neck out would also pull the top away from the guitar! On this one, however, I can clearly see that the neck and fretboard have been off before, which in turn means the top would have already been cut around the dovetail to allow the neck removal. Your guitar repairman should be aware of these potential catastrophes!

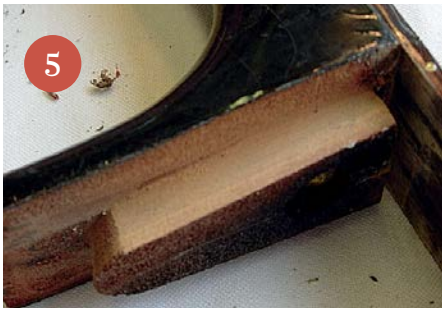
So, with the neck removed, it's time to change the neck angle. The first thing we need to do is thoroughly clean up the neck join. On this J45 there's a 2.5mm spruce packer under the end of fretboard 3 that I'm going to remove and replace (using an ultra-sharp chisel, of course, as it cuts so much better).

The next job is to clean up the joint 4 5. For this I'm using a sanding block with some angles cut on it to allow me to get around and into the dovetail. You need to produce a perfectly clean and flat surface, which we can later build up with some veneer. If the surface is not completely flat the veneer will not stick well, giving a weak join, which could break.

With the dovetail cleaned up we should now have quite a 'loose' joint, and this will enable us to







adjust the neck angle. This job normally requires about six hands to hold everything together. The neck must be held with the straight-edge at the correct angle so that it just clears the top of the bridge 6; use some packers under the joint to keep the neck in the correct position.

Once you've got the neck at the right angle the heel will need to be scribed around so that we can recut it 7. It needs to sit perfectly against the side of the guitar. If you're pulling the neck back, remember that you should be removing material from the bottom of the heel: this is important. If you remove material from the top of the heel you'll push the neck and fretboard closer to the bridge, wrecking the intonation, which can only be fixed by filling and recutting the saddle slot. To scribe the heel joint I use the edge of a ruler with a cutting angle ground on one edge, which is generally the right thickness at about 1mm. Of course, the surface of the ruler has no sharp edges on it, apart from the one we use to do the cutting (you can also put some masking tape on the body of the guitar to make sure you don't scratch it). The method is to push the ruler around the heel, scribing the shoulder at the same time, and creating a line about 0.5mm deep. As you can see, it's possible to get a really nice clean line.

Next, using a Stanley knife blade, we can pick off the timber under the line that's been scribed, giving a really clean line to work to with the chisel 8. We'll work all around the heel with the chisel, frequently checking the joint to make sure we're not taking to much away, 9 and at the same time also making sure that the neck is not only at the right angle but also thinking three-dimensionally to ensure the neck is in line with the bridge and the pin holes 10. It's easy to get carried away with the neck angle and to forget about lining it all up with the bridge; this could result in real embarrassment when you get to stringing up the guitar and discover that the strings are hanging over one edge of the fingerboard.

Now we've cut the shoulder with the chisel we can move on to using some glasspaper to give us a perfect fit 11. We'll mark the surface of the shoulder with a pencil, then place the neck in the joint with a piece of glasspaper under it. By gently pulling the paper out with a little pressure on the neck, we'll be able to get an exact join. When all the pencil lines have gone, it should be just right.

Before moving on to fitting the dovetail I'm going to replace the packing-piece that I removed earlier from under the fretboard. The old packer was a 2.5mm thick piece of spruce, so we'll replace it with something similar 12. The only thing to make sure of here is to use the correct clamping blocks; the upper one should match the fingerboard radius, while the one on the back should be flat. Once the glue has dried, the excess >

1 Assessing the situation. Typically, the top of the guitar has bellied up

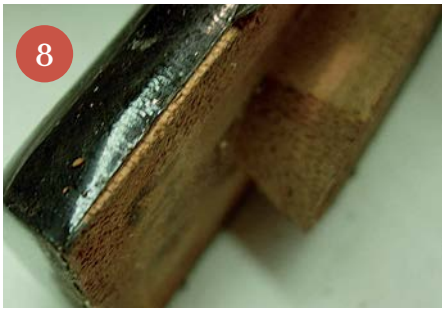
2 Straight-edge test. Lines up halfway down the bridge

3 Chisel work. Removing the packer under the fretboard

4 Cleaning the joint. Notice the natty angled sanding block

5 Heel cleaned. We used the same angled block as in pic 4e

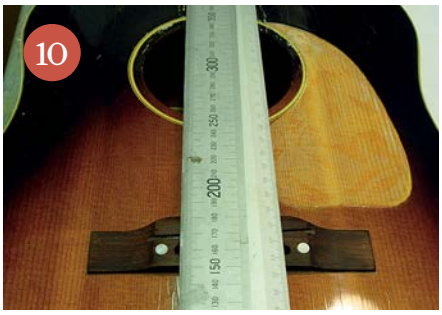
6 Correct neck angle. The ruler rests on top of the bridge

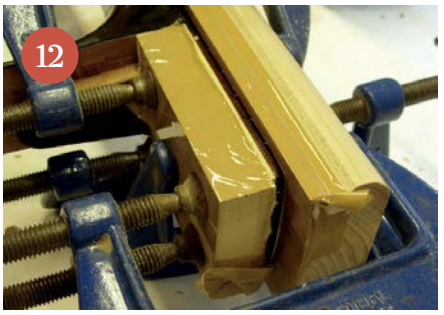


7 Scribing around the heel. We're using a sharpened ruler

8 Next step removing the strip of lacquer below the line

9 Delicate work chiselling to remove just the right amount





10 More checks making sure the neck lines up with bridge

11 Fitting heel to sides using the 'glasspaper pull' method

12 New packing piece glued in place under the fingerboard

timber can be planed off **13**. A handy tip when planing across the end grain, by the way, is to always plane into the centre; if you go all the way across in one swoop, you could easily split out the edges of the fretboard and the spruce.

A correctly-fitted dovetail is a remarkable thing: it pulls itself together in all directions. In fact, a perfect one won't even need any clamps when you glue it. On this one, though, we'll need to use a couple of clamps to hold the fretboard down. Since our dovetail is loose-fitting at this point, we'll employ a piece of veneer on each side of the neck's dovetail **14**. Unless it's a particularly bad fit, one or two pieces are normally enough (in the past, though, I've had to build up dovetails by as much as 6mm). You need to have enough veneer in there to keep the whole neck sticking up by about 6mm; this will give enough to re-fit the joint when we've glued the veneer on. We'll need three clamping cauls to clamp the veneers with an even pressure all over **15**. Also, we'll wrap them in parcel tape to stop them sticking to the dovetail.

The next part is not easy. With the dovetail tighter than it should be it now has to be fitted, and the best way I've found is to use chalk dust. By covering one surface with chalk and gently pushing it into the joint, the dust will be transferred from one surface to the other. The point that makes contact first, of course, will be the tightest part; by sanding or chiselling a little off at this point the joint will close up. This may take 20 or 30 attempts to get right, but you should end up with the chalk dust transferring from one side to the other all the way down the dovetail.

Once you're happy with the fit – which should have no play in any direction – it can be glued together. Remember, glue does not fill gaps, so the better the fit the stronger it will be and the more efficiently it will transfer the sound. Before the glue goes on, do one last check **16** to make sure everything is in line, and when the glue has gone on check it once again, both for the angle to the bridge and to make sure it's lined up with the bridge pin holes.

To glue the two parts together **17** it's necessary to use the radiussed block on the top of the fretboard and a clamping caul to go around the braces on the inside of the guitar. The glue I'm using is Titebond aliphatic resin. It dries harder than PVA and will keep our guitar together for many years to come. The neck joint will now need to be left for 24 hours before the guitar can be can refretted **18**, and we'll also do a little refinishing around the neck.

This, then, is how you approach the tricky but rewarding task of a neck reset. One warning: if you think you might like to have a go at work like this yourself, we seriously recommend you do not start with a 1950 Gibson!

13 Trimming packing piece Plane to centre to avoid chipping

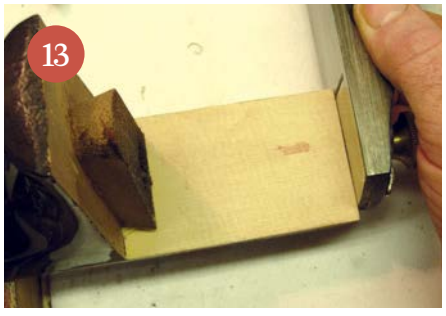
14 Preparing the packing veneers. Place in the rout first...

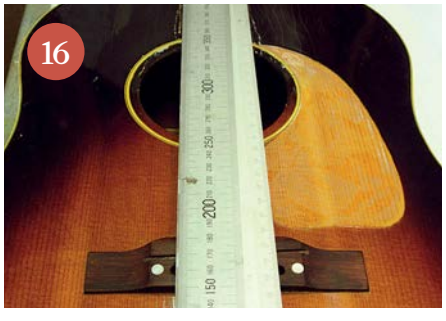
15 Clamping up and gluing to the sides of the dovetaill

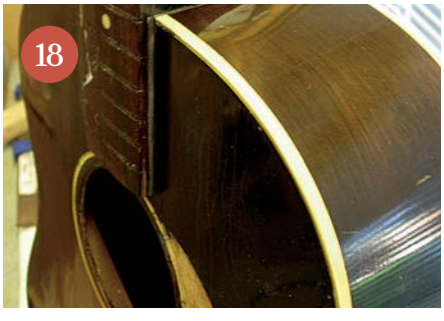
16 Check straightness again lining up perfectly with the pin holess

17 Final gluing. One big clamp, and one for the fingerboard

18 Neck set done, just a refret and some touching up to go







ACOUSTIC WORKSHOP

RESCUE PLAN

Buying an acoustic guitar with 'issues' needn't be too much of a risk if you're handy and prepared to get stuck in. **HUW PRICE** snapped up a promising-looking contender and set to work

From the outset I want to say that the guitar we've chosen to be our patient, a Recording King, is a great guitar. Essentially it's a pre-war style Martin replica with solid mahogany back and sides, a solid sitka spruce top and a one-piece mahogany neck with a soft V profile. There's also herringbone purfling, ivoroid binding and ebony for the fingerboard and bridge, and I was also surprised to discover that the finish is nitrocellulose and bone is used for the nut and saddle. Recording King's attention to detail is more than evident from the open-ended saddle slot and the slot-head tuner screws. The specs might read like that of an expensive, high-end US-made model, but the ROS-626 sells new for around £600. I managed to pick this example up on Ebay for about £225 because it had some issues. After a week or so of procrastination, mostly because I was enjoying the guitar too much, it was time to address the fingerboard cracks, re-glue the lifting bridge and make a new saddle. >

1 CRACKING UP

The fingerboard cracks – which, to be fair, the eBay seller had photographed to make them look worse than they actually were – consisted of several long, hairline cracks running the length of the fingerboard, and they needed to be stabilised.

The cracks were too fine to force in regular PVA wood glue or epoxy, so I resorted to medium viscosity superglue. Superglue is ideal because it wicks straight into cracks and it doesn't need clamping. After the first application I scraped the board flush with Stanley blades, rubbed some ebony dust into the cracks and applied a second dose of superglue. After the second scraping the cracks had all but vanished, leaving a beautifully smooth fingerboard. I followed up with some 1400 grit micromesh and some lemon oil and the board felt better than new. The factory had dyed the ebony for a uniformly black look; the scraping revealed the grain plus some natural brown tones, and to my eyes it looked a lot more attractive.

Superglue wicks into tight cracks, and you don't need to clamp

Snapped Stanley knife blades will scrape the hardened Superglue flush

TOOLBOX
- Three bridge clamps
- Palette knife
- Titebond Original glue
- File
- Jeweller's saw
- Micromesh
- Metal polish
- Superglue
- Ebony dust
- Stanley knife blade

2 REMOVING THE BRIDGE

Removing the bridge is a fairly serious matter, but here it had to be done because it was already separating from the top. First, slivers of paper were inserted under the bridge crack and marked to determine the extent of separation. Three things are needed to remove an acoustic guitar bridge – a heat source, a wafer-thin palette knife and strong nerves. Actually that last one's a joke... it's not that difficult, but you do need to be careful and patient.

Luthiers often use specialist bridge-sized heating pads but, like many others, I use a regular clothes iron. First I cut a rectangle out of a piece of corrugated cardboard to protect the finish, then held the hot iron on the bridge for around five minutes (not forgetting to turn off the steam setting).

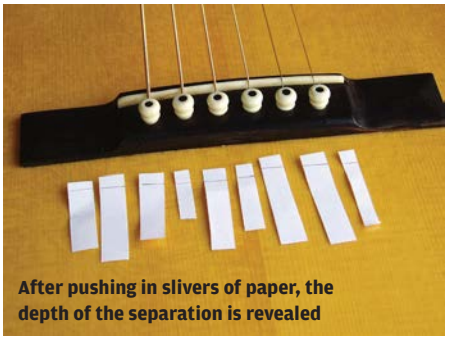
Once the bridge felt pretty hot I removed the cardboard and slid the palette knife under the existing gap. It went in quite easily and I gradually worked my way around the bridge, occasionally stopping to apply more heat. All the while you must 'ease' the palette knife between the bridge and the top, taking great care not to damage the finish and trying to work from the outside edges towards the centre rather than pushing the knife straight through.

It's imperative to do as little damage to the top as possible, so never try to lift or prise the bridge off. If you get bored or impatient, just stop, have a break and come back to it later. Removing this bridge took me around 15 minutes, but relatively little of its surface area was actually in contact with the top.

When the bridge finally released it was obvious why the back had been pulling up. Read any book on acoustic guitar building and you will learn that the soundboard wood underneath the bridge needs to be exposed for wood glue to adhere. Wood glue won't stick to polyester, acrylic or nitro finishes. Some builders carefully scrape away the finish in the bridge area after the guitar has been finished; others apply masking tape to the bridge area of top of the guitar prior to spraying. The tape is then peeled off to expose bare wood when it's time to fit the bridge.

So far as I can tell, someone at the Recording King factory simply scored out a rectangle using a sharp blade then chiselled away the finish – along with a fair amount of the spruce top. This left an uneven surface, along with some nasty gouges. Worse still, there was a strip of intact finish almost 10mm wide all the way along the area under the back of the bridge. No wonder it was pulling loose.

This struck me as bizarre considering the otherwise outstanding build quality for a guitar in this price range. However I have since learned that in early June 2011 two of Recording King's head honchos re-trained the factory's bridge gluing staff to ensure finish scraping and application was standardised and correct. Hopefully the well-documented Recording King bridge lifting issues have now been remedied.


After pushing in slivers of paper, the depth of the separation is revealed

A cardbord mask is used to protect the top of the guitar from the heat of the iron

The softened glue allows the palette knife blade to slide in fairly easily. Work all around from the outside to the centre

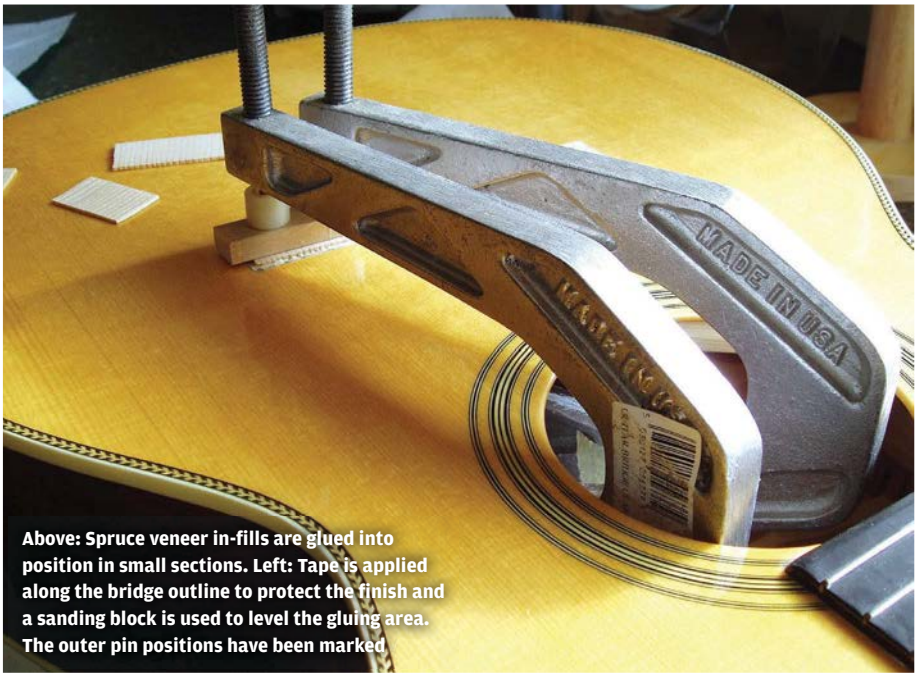
You can expect some spruce too come away

The black tape outline shows that the finish wasn't properly scraped back at the factory

3 PREPARING THE BRIDGE AREA

All the flaky wood fibres pulled loose by the removal of the bridge need to be sorted out and by the time it was sanded we had a smooth concave trough in the under-bridge area. Next we took a spruce offcut and sanded it down to a thickness of just over 1mm. The offcut was then divided into smaller lengths, and the undersides were sanded to create a slight curve. This curve, coupled with the clamping pressure, allowed our spruce patches to conform to the damaged surface of the body.

Once the pieces were glued in place they were left for 24 hours. Insulation tape was carefully laid along the edges of the bridge footprint, and we used a very small sanding block to make the patches level with the surrounding top. We chose Titebond Original glue; it sets very hard and will prohibit the bridge from moving. The glue joint should be stronger than the wood fibres, so there shouldn't be any structural issues.



Above: Spruce veneer in-fills are glued into position in small sections. Left: Tape is applied along the bridge outline to protect the finish and a sanding block is used to level the gluing area. The outer pin positions have been marked

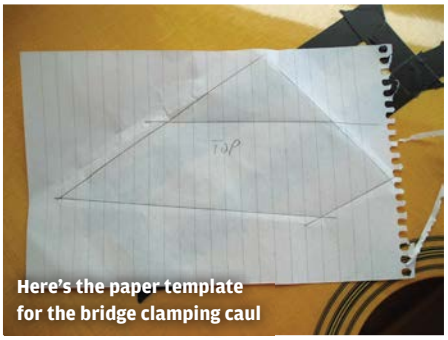
4 FIXING THE BRIDGE

Now for gluing the bridge back on. I decided to make a bridge clamping caul, because it's tricky to make bridge clamps hold position on scalloped braces. I held a sheet of white paper against the bridge plate with my fingers and used my thumbnail to push the paper into the corners of the brace/bridge plate intersection to mark the area. You can mark the front and back edges of the bridge plate the same way, and when you remove the paper the crease lines will provide a reasonably accurate template for your clamping block. Next, transfer the template to a piece of scrap MDF and cut it to size, then cut another piece, slightly wider, to overhang the X braces each side of the bridge plate. Then I attached cork pads to the overhangs to protect the braces and drilled two 10mm holes for the outer bridge pins.

Since the original bridge outline was clearly visible, I placed the bridge in position and marked the position of the outer pin holes on our freshly sanded gluing surface. I then drilled through the spruce patches and increased the diameter to accommodate the bridge pins using a reamer.

The beauty of doing a bridge refit, as opposed to a first-time bridge fit, is that you can use the existing bridge pin holes to position the bridge and stop it sliding around when it has been glued (of course this assumes that the bridge was correctly positioned in the first place). Just make sure you use plastic pins, because wooden pins will stick to the wood glue – and if that happens you'll be in real trouble.

Another spruce off-cut was placed on top of the bridge along with two more holes for the bridge pins. This was done for protection and to distribute the clamping pressure across the bridge. So-called 'pyramid' bridges like this one are tricky to clamp because of those pointy bits on the top, so I stuck some cork pads onto the ends to make life easier.



Here's the paper template for the bridge clamping caul

Top, the upper bridge caul; bottom, the inside clamping caul with cork X brace overhangs

The bridge must be scraped and sanded to remove all trace of the old glue

At last the bridge is clamped and the guitar is set aside for 24 hours. Note bridge pins

Before clamping I thoroughly scraped and cleaned the bridge base to remove all traces of glue and old finish. This revealed that the ebony had been dyed black because the natural timber had so much brown colouring. The rough-looking visible surfaces were sanded with 320 grit paper followed by micromesh and, after masking off the underside of the bridge, I gave it a final buff up with black shoe polish.

The clamping caul was covered in plastic packing tape and secured to the bridge plate using two very small pieces of double-sided tape for easy removal. The bridge was positioned using the pins and clamped using three bridge clamps. The glue squeeze out was cleaned up immediately with a damp cloth and the guitar was set aside for 24 hours before the clamps were removed.

5 SADDLING UP

The bridge had an open-ended bridge saddle slot – as used by Martin prior to 1965 – but somewhere along the line this guitar had acquired a post-1965 style saddle. A new saddle was required to fill the slot properly and all doubt was extinguished when we discovered a thin shim of plastic binding at the bottom of the slot. I already knew that the saddle height was pretty much spot on – albeit with the shim in situ – so at least I had a decent template to work from.

Open saddle slot – but the saddle old saddle doesn't match

The new saddle has been cut and filed and the ends now look exactly as they should

A bone blank was inserted into the slot and a sharp pencil was used to trace the curves of the bridge onto the new saddle at both ends of the slot. Next, the blank was removed and the old saddle was placed on top to trace its shape and size onto the new blank. The ends were then drawn free-hand to create a smooth transition between the old and new shapes.

A jeweller's saw was used to rough-cut the bone blank and a file was used to bring the height of the new saddle close to the original. The intonation was already very good, but notes were slightly flat at the 12th fret so I decided to bring the string take-off point on the top of the saddle closer to the bridge pins. After a quick rub with micromesh and a buff with chrome polish the saddle was pushed into its slot and it was finally time to put the strings back on.

Verdict

The Recording King ROS-626 has an archetypal old-school slothead tone that's perfectly suited to blues, slide, ragtime and even open-tuned Celtic style meanderings. Even in stock form this guitar significantly exceeded my expectations, so a big thanks to Alex and Reuben for telling me about it.

Fixing the bridge-to-body joint noticeably refined the Recording King's tone, but replacing the saddle had a much more profound effect. The guitar felt freed up and much louder, and the bottom end gained a lot of power. The slight crashiness we had noticed was virtually gone and the overall clarity, smoothness and balance improved enormously. The work's definitely been worth it, and this one's a keeper.

SSDPS15

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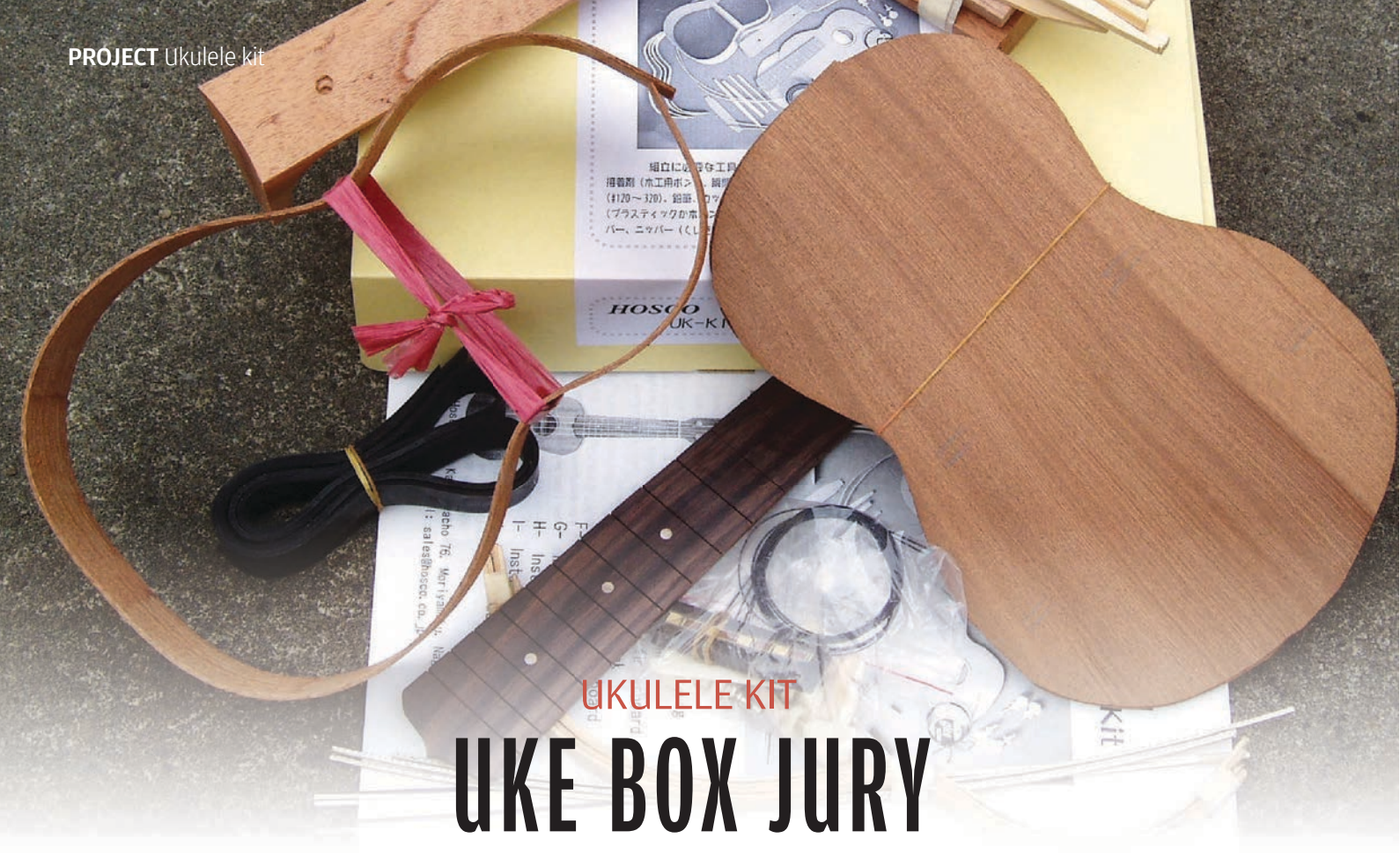


UKULELE KIT

UKE BOX JURY

If you've ever wanted to build your first instrument then a ukulele kit is the absolute best place to start: small, manageable, simple and with an outcome packed with fun and joy. Say 'Aloha!' to **HUW PRICE**

TOOLBOX
- **Wood glue & Original glue**
- **finishing materials**
- **Titebond**
- **File**
- **Jeweller's saw**
- **Micromesh**
- **Metal polish**
- **Superglue**
- **Stanley knife blade**

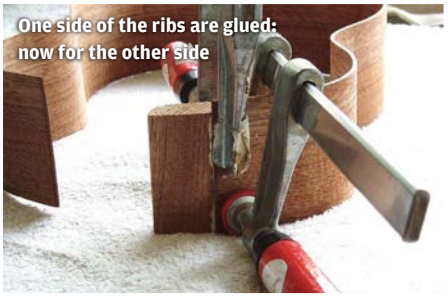
When the package arrived, at first sight it was hard to believe that anybody could fit a ukulele into such a small box. A quick check confirmed that everything was present and correct. Japanese company Hosco offer various ukulele kits, both Soprano and Tenor, but this £78 package from Tonetech is the all-solid mahogany Soprano version with pre-slotted and dotted rosewood fingerboard and banjo-style tuners.

The package includes front and back plates; pre-bent sides; heel and neck blocks; a bridge, bone saddle and nut; and all the braces. You even get a set of strings. All that you'll need to provide is some wood glue, finishing materials and a few days work. So after a quick read through the instructions, we were ready to get started.

1 GLUING IN THE BLOCKS

Draw a centre line down the heel block and you're ready to glue

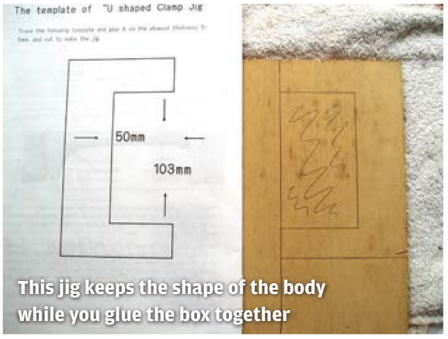
Unlike the acoustic guitar kits we've built before, the uke kit's rims were bent from a single piece of mahogany rather than two pieces. We drew a centre line down the gluing surface of the neck block and applied glue to one side only. One end of the rim was clamped with its edge carefully butted up against the centre line, then glue was applied to the other half of the neck block, and the other side was clamped up. Next we attached the tail block, and the whole assembly was set aside.



One side of the ribs are glued: now for the other side

Heel block and tail block all in place, with string to keep the shape of the waist

2 CUTTING THE JIG



This jig keeps the shape of the body while you glue the box together

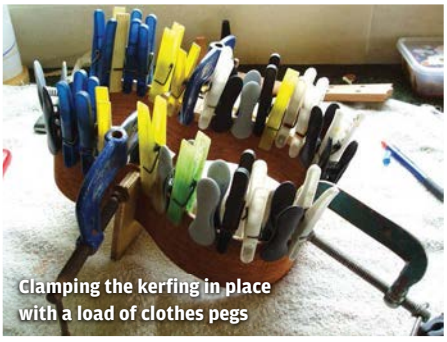
While we waited for the glue to dry, we cut out the 'U' shaped clamp jig shown on the back page of the instructions from 5mm plywood. The purpose of this is to slide over the body to define the width of the waist and hold the sides square. Once the blocks were firmly fixed, we removed the clamps and slipped the jig onto the rims to form the correct outline shape for the body.

3 FIXING THE LININGS

The kit contains four pre-bent strips of wood that must be glued to the sides. These provide extra rigidity and widen the gluing area for the top and back plates. The top linings followed the flat edge of the sides and we glued those on first with the jig in place. All you need to clamp the strips is a bag full of clothes pegs.

The back strips were glued in at an angle from the taller heel block to the shorter neck block. Once the glue had dried we filed and planed the excess mahogany away, then trued up the surfaces of the sides and the strips using a wide, flat sanding block.

The linings or 'kerfings' come pre-bent too. Which is nice



Clamping the kerfing in place with a load of clothes pegs

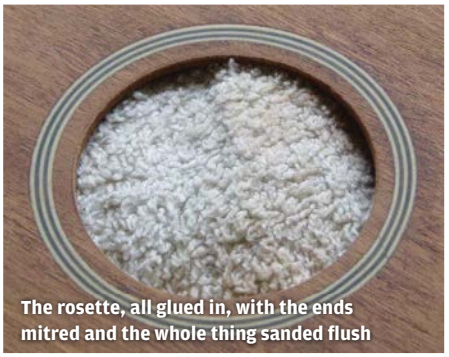
4 MAKING THE ROSETTE

The ukulele kit comes with the soundhole pre-cut along with a neat little trough ready routed to house the rosette. Hosco provide three strips of white plastic and two of black. With acoustic guitar builds you can usually hide any joints beneath the fingerboard; unfortunately the whole rosette remains visible with this design so attention to detail is needed.

First, we pushed the strips into the trough to hold them together, then dripped a little superglue over the centimetre at the very end and pulled the strips back out after a couple of seconds. The superglue fixed the strips together; just don't leave them in too long, or the plastic might stick to the wood too. That comes later.

Next, the superglued end of the rosette strips was placed in a mitre block and cut at a 45 degree angle. The strips were then put back into the rout, starting at the mitred end, and we held them in place by using patches of masking tape placed at intervals every few centimetres.

Next, we worked our way around the rosette with superglue. The thin consistency of superglue allows it to wick in between the strips and through to the wood beneath.



The rosette, all glued in, with the ends mitred and the whole thing sanded flush

We left the very final section un-glued and used a craft knife to cut away tiny shavings of plastic until the ends matched up. This part is fiddly and time consuming, but don't rush it or you may end up with a blemish that will bother you every time you look at your uke. And we wouldn't want that.

5 GLUING THE BRACES

The instructions provide plenty of tips on how to glue the various components together with the bare minimum of clamps. However if, like us, you do have a decent number of clamps at your disposal then you may as well use them, because it's easier.

For this uke build there are only two braces each on the back and front, plus a bridge plate. The approximate positions are marked out, but we took the opportunity to determine our centre lines and ensure the brace positions were squared up. One thing to note is that the gluing surfaces of the top braces are flat, while the back braces are curved. The braces were a little rough and ready, so we took the opportunity to finesse them a bit, evening up the curves and shaving them slightly to enhance resonance.

The top has only two braces, plus a bridge plate

6 ATTACHING THE TOP

To determine the exact positioning for the top we flicked forward in the instructions to find the recommended distance between the neck joint and the bridge. Since the bridge plate was already on, we just made sure it would end up directly below the bridge. With our plywood jig in situ we positioned the rims over the top plate and marked the inside edges of the rims on the braces. Using a fine saw blade we cut through the braces and used a chisel to remove the excess from the brace ends to achieve a nice tight fit. Glue was applied to the surface of the rims as well as the neck and tail blocks and the top was clamped in position while the glue dried.

Gluing the top onto the box. The excess top material can easily be chiselled off later

7 FIXING THE NECK

From the moment we read the instructions we had concerns about gluing the neck. We have done mortise and tenon joints and bolt-on necks, but this kit involves simply butting the end of the neck up against the body and holding then together while the glue sets. The instructions are very vague but suggest augmenting the glue joint with a dowel.

The thing is, should you drill the dowel holes in the neck block and neck heel separately, or with the neck and body dry clamped together? If so, that would mean doing the drilling before the back is attached. We tried this and found it impossible because we couldn't clamp the neck firmly enough to the body. Besides, even if we had succeeded in drilling two perfectly aligned holes, trying to tap the glued up dowel into the neck joint and trim it flush while working through the tiny soundhole wasn't a very attractive prospect.

We decided to deviate from the instructions, and glued the body onto the neck before attaching the back plate. The thick rubber band included with the kit provided enough pressure to hold the neck against the body, and we used a G-clamp to ensure the top surface of the body lined up with the surface of the neck, onto which the fingerboard would later be attached.

Once the glue had dried we drilled a dowel hole through the neck block into the neck, covered the 6mm dowel with glue, and pushed it into the hole. We cut the end of the dowel flush with the surface of the heel block and sanded everything smooth.

We decided to drill our dowel hole after the neck was glued on

8 ATTACHING THE BACK

The neck heel protruded beyond the gluing surface of the neck block, so it needed to be trimmed flush before we could glue on the back. We chose to use a classical guitar building technique where the back plate continues over the heel. It eliminates the join line where heel meets body and gives extra strength to prevent the neck tilting forward. The brace overhangs were trimmed back bit by bit until we achieved a snug fit, and the back was glued on.

Gluing the back on. Can you ever have too many clamps in your garage? No

9 THE FINGERBOARD

The rosewood fingerboard in our ukulele kit came pre-slotted, and we installed the frets before gluing it to the neck. We tapped them in with a plastic-tipped mallet, then snipped the edges flush with the fingerboard using a fret nippers. Using the same straight-edge sanding block that we used to sand the rims flush, we removed any rough edges from the ends of the frets and then tilted the block slightly to angle the fret ends.

The centre line was still marked on our neck and body, so we aligned them with the centre line we had previously marked out on the fingerboard and then glued them together. When you glue pieces like this, the slippery nature of wet glue can cause the pieces to move around as clamping pressure is applied. When you bring the pieces together, try leaving them unclamped for a few minutes. This allows the glue time to get an initial 'grab' and the pieces will be less prone to move about under the clamps.

When you do apply clamping pressure using several clamps, start off with them finger-tight and then apply a small turn to each clamp one by one. Once you see glue squeeze out all along the joint line, you can be confident that you have applied sufficient pressure.

Go with the grain to trim top and back: here, you'll be working down into the waist

10 TRIMMING AND PREPPING

As supplied the top and back plates were crudely cut, so there was a substantial amount of overhang that had to be trimmed flush with the sides. We used a fresh pack of Stanley knife blades. Just work slowly, be very careful with your fingers and follow the grain of the wood. If it cuts easily and smoothly, you're probably working with the grain. If the wood starts to chip and flake, you're probably going against the grain and you should work from the opposite direction. As you trim in the neck and tail block areas you'll be cutting across the grain, which can be tricky. Try pushing the blade through the wood, along the grain line, at 1mm intervals to create a 'comb' effect, then slice across the grain. If you do about 10mm at a time, it's easy.

You don't need to trim 100 per cent flush with the sides because you can complete the job by sanding. Mahogany is an easy wood to work with, and about half an hour with a detail sander tidied up the edges and smoothed out the sides at the same time. We continued using the detail sander and hand sanding until the body and neck were ready for finishing.

11 LOCATING THE BRIDGE

Bridges must be glued to bare wood, not lacquer, for maximum strength. Placing a patch of masking tape over the bridge area before the finish is applied is much easier and quicker than trying to scrape or sand away the finish after it's been applied.

We went back to the instructions for guidance on locating the bridge. This uke has a scale length of 348mm, so the instructions suggested locating the saddle position 177mm from the 12th fret (the extra 3mm is added to ensure the uke intonates properly). We placed a couple of strips of masking tape over the bridge area then held a straight edge against the edges of the fingerboard and drew the neck lines onto the masking tape along with the centre line.

Next we marked the neck lines 177mm from the 12th fret and drew a connecting line between them. The bridge was centralised with its saddle slot aligned with the 177mm line, and we drew around the outside edge with a pencil. A craft knife was used to cut through the masking tape just inside the pencil lines and then the excess masking tape was removed ,leaving the bridge patch in place. Do take care to peel the tape away along the grain lines rather than across it, or otherwise you risk removing flakes of wood along with the tape.

The bridge position is marked on the patch of masking tape

Then the excess tape is cut away. Double-check that the saddle's in the right place

12 APPLYING THE FINISH

Tonetech suggested applying grain filler first, which is the usual procedure for mahogany. We used white spirit-based filler that we brushed on, allowed to dry for a short while, then wiped off across the grain before leaving to dry overnight. Although not included with the kit, Tonetech supplied us with water-based sanding sealer and gloss lacquer (£8.50 each). These products can be sprayed or brushed onto the instrument; we decided to use a brush.

The sealer goes on quite thick, and after drying overnight it sanded smooth with ease. The lacquer dries very quickly and, as recommended, we brushed on four coats of lacquer with one-hour intervals between each coat. It's very tricky to avoid getting brush marks and lacquer build-up around the edges and even after the finish is wet- and dry-sanded then buffed up with polishing compound, it doesn't have the depth that we'd associate with nitrocellulose. Maybe you'll have better luck, but we regretted not spraying nitro as usual.

Filling the grain of the mahogany with a white spirit-based filler

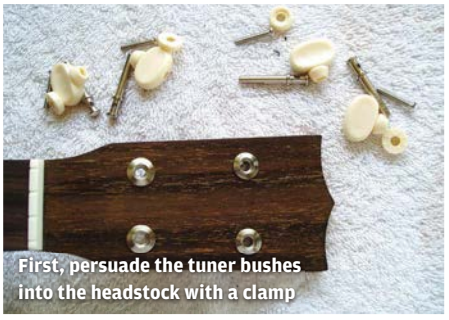
13 FIXING THE BRIDGE

With the finish done, it's time to glue on the bridge. We peeled off the patch of masking tape covering the bridge area and placed a piece of masking tape at each end of the bridge area with a third piece just in front. Next we marked the 177mm point once again to align the saddle slot, and then we marked the centre point of the bridge. Glue was applied to the base of the bridge – and we found that the tiny body made it easy to clamp the bridge in place from the outside. With the glue set, we removed the clamps and glued on the cover strip over the redundant screw holes.

With the bridge masking removed, we apply three pieces of tape as location markers

14 TUNERS AND NUT

The stock nut was a fine fit and we simply fixed it in place with a few dots of superglue. The tuner bushes were pressed in from the front using a G clamp; never attempt to hammer them in, because you will inevitably dent the headstock. The tuner posts also push in from the front, and they're secured by screws that pass through the tuner buttons.



First, persuade the tuner bushes into the headstock with a clamp

The finished headstock, with tuners all assembled and the nut in place

15 STRING UP AND PLAY

The saddle was inserted into the bridge slot and knots were tied at one end of the strings to secure them in their string slots at the back of the bridge. The tuners work on the friction principle with a 1:1 ratio. Although they're attractive and have an aura of authenticity, they're pretty crude. If you have hopes of building a truly playable and practical instrument, we'd suggest a tuner upgrade would be a smart move.

Strung up and ready to go: our kit ukulele is ready for its first sunset serenade

Verdict

A success? Sure. Though the instructions sometimes came across like they were translated from the original Japanese via Google Translate, they were quite easy to follow. As kits go, this was about as simple as they come. It would be a great introduction to building, and anybody who has previously completed an acoustic guitar kit will find this a walk in the park. We completed our ukulele over five days.

Getting our uke in tune and keeping it tune was a bit of a struggle – maybe those plastic strings needed some time to stretch out and settle down – but the tone was warm, mellow and woody. Some cheaper ukes have a plinky, thin tone but this one sounds like an all-solid wood instrument.

Considering that you can buy an all-solid mahogany uke such as the Ortega RU10 (with decent tuners and a gig bag) for just over £100, building your own doesn't really make economic sense. But that's not really the point: putting this kit together is a lot of fun, you'll have the unique pride of playing an instrument you built yourself, and it sounds pretty sweet too.

CLASSICAL WORKSHOP

NYLON RENOVATIONS

Old hand-me-down nylon strung guitars have kick-started many a youngster's playing career, but after a little work you might decide yours is a keeper. **DAVE KING** gets an old friend ready for a new home...

I regularly get people bringing in old nylon string guitars for repair and setup. These instruments have often been in the cupboard for 30 years and many have a sentimental attachment (ah, the memory of that first E minor). While some are beyond saving, you do find some with solid tops and decent fretboards that can be brought back to life, but few are worth paying someone over a hundred pounds to sort them out...

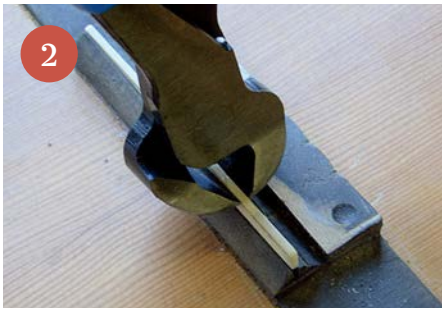
On the other hand, with a little love and care most of the work can be done at home. The nylon-string guitar we have here was picked up at a boot fair near Bryon Bay in Australia around 15 years ago for $2. After serving as a travel guitar for years it went into the cupboard. However, it does have a solid back and sides, reasonable tuners and a neck that's pretty straight – so it's worth the effort.

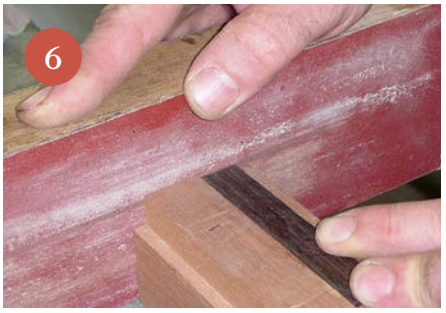
Have a good look at the guitar before you do anything, work out what needs doing, and tackle one task at a time. First, we're going to work on the bridge 1. The tie block (the bit the string goes around) is a bit tatty. It's made from

1 Bridge Not pretty, but saveable. Note the added screws

2 Removing the saddle Fret. Pullers will hoick it out nicely

3 Tie block height is 1.5mm lower to allow for the veneer





a soft piece of maple and the strings have pulled into it over the years.

The best thing we can do is to plane it down a little and fix a Macassar ebony veneer to the top (it would often be made from bone but bone is difficult to work with in this situation, and ebony will work well enough). Before you start to plane the bridge down, cut out a cardboard template to go around the bridge; this will protect the soundboard while you're working on it. You'll also need to pull the saddle out: for this, use a pair of fret pullers 2. The tie block needs to finish up about half a millimetre below the surface where the saddle sits, so allowing for the thickness of the ebony we're going to put on (1mm), we need to be a total of 1.5mm lower 3. The best way to plane a bridge down is to use a very sharp block plane 4 (blunt tools never, ever work properly).

This bridge has had screws put in it at some point (probably to hold it in place while being glued), so we need to make sure we don't go over the screws with the plane, as blades really dislike metal.

If you want to remove them then do so, and then drill the holes a little deeper and replace them.

The ebony I'm using was bought as a head veneer from David Dykes Luthier Supplies (01435 812315) so it's already the right thickness. Cut the bridge veneer about half a millimetre over length using a cutting block 5; the ends can be sanded smooth and to the correct length using a sanding block and cutting block. Make sure the end of the cutting block is square: this way the sanding block can run on the end of it, ensuring the veneer ends are sanded squarely 6. Also make sure the veneer is the right size – it will be difficult to reduce it once glued to the bridge.

To glue the veneer, use some bridge clamps with blocks of MDF on the feet; I'm using a block with some cork glued to it to add more protection and to ensure an even clamping pressure 7 8. Apply the glue (Titebond's the stuff) to the face of the bridge, and hold the veneer firmly with your fingers for a minute; this lets the glue 'grab' a little, and stops it from sliding about when you tighten the clamps. Place the clamping block over the veneer, clamp it in place, clean off any excess glue and leave it to dry for 24 hours.

Once dry, the veneer can be cleaned up using sanding sticks: gently take the edges off the tie block and clean the top face 9. Our bridge still looks a little worse for wear, so we'll clean the rest of it up using glasspaper, then stain the rest of the bridge black again using wood stain from a DIY shop 10. Mask the area around the bridge, brush on the stain, and be very careful: use too much and it'll run on to the top.

Now we can move onto stoning the frets 11, re-profiling the tops and getting rid of the sharp edges. Use a flat oilstone to level >

4 Planing the bridge. Your plane should be scary sharp

5 Preparing the veneer. We're using 1mm thick ebony

6 Square ends. Use a sanding block and a cutting block

7 Under Pressure. MDF and cork blocks help keep it even

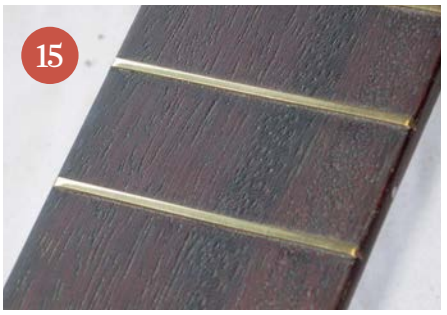
8 Gluing the veneer. You'll need these proper long C clamps

9 Finishing off. A sanding stick gives the final touch

10 Adding stain. Careful: a little black stain goes a very long way

11 Stoning the frets. Nylon strings mean much less wear and tear

12 Check fretboard. A quality straight edge is a lovely thing



13 Fret ends. This block makes sure of a 35 degree angle

14 Profiling frets. Work from 320 wet and dry up to 600

15 Frets polished. Fine wire wool and lemon oil is the trick

16 Adding side dots. A useful addition for beginners

17 Drill bit extension. Useful when access gets tricky

18 Cutting off the dots. A sharp chisel is best. Be careful

19 Saddle angle. Should point downwards about 20 degrees

20 Sanding the saddle. Make sure you're keeping it square

21 Lubing the tuners. Just a tiny spot will be enough

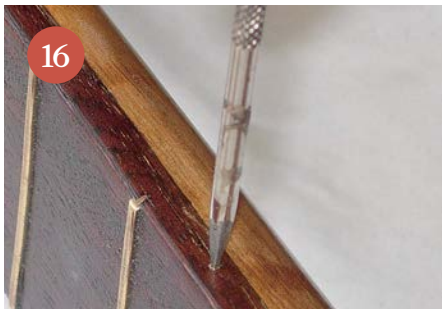
the frets, working your way up and down the fretboard using a circular motion with the stone. The frets on our test instrument are pretty good and the neck is quite straight, so all that's needed is a very light stoning. When the frets are level use an angled block set to 35 degrees and a sanding stick **13** to smooth off the edges of the frets. Now all the frets are level with the edge of the fretboard, it's the time to take off any sharp edges. I use a triangular needle file with the edges sanded smooth to stop the file from removing wood from the fretboard.

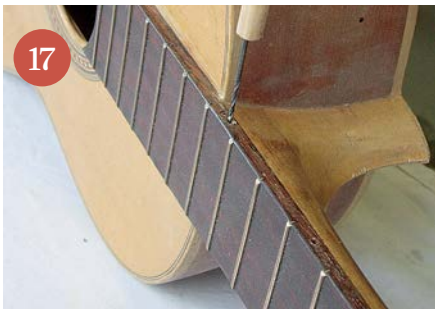
Now the frets can be reprofiled using a fret file, which are available in different sizes to suit your fret wire. Use either a fretboard protector (Touchstone Tonewoods 01737 221064) or mask off between the frets using masking tape to avoid scratching the fretboard. Start with some 320 grit paper wrapped around the file **14**, keep going until you've removed any marks left by the oilstone, then move up to 600 grit wet and dry **15**. When the frets are nicely profiled is give them a polish with 0000-grade wire wool and lemon oil.

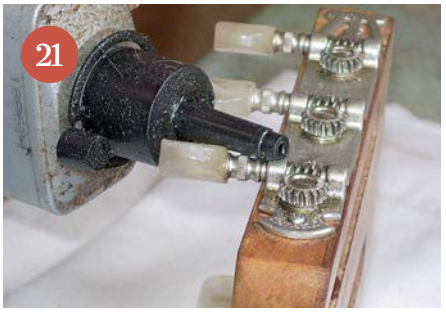
How about some side dots? Most classical players don't need them, but I struggle with guitar playing most of the time and any help I can get is good, so this will certainly be true for the average beginner. The third, fifth, seventh, ninth and 12th positions will do just fine **16**. The plastic bar that I'm using comes in various colours and sizes: a white 2mm diameter one will do the job. Mark the centres of the holes with a scriber, and check at least twice; there's very little more annoying than drilling the holes in the wrong place. You'll probably be able to use a drill for most of the holes, but drilling at the 12 fret can be difficult. I use a length of dowel, and drill a hole in the end with a 2mm drill bit . I then glue the drill bit in with superglue, using an 'extended' drill bit **18** that will allow you to get to the 12th fret markers (or further, if you want to). You don't need to use it in the actual drill itself; just turn the dowel by hand, as you're only going in a couple of millimetres. Put a little superglue in the holes and tap the bar in gently with a hammer, leave the to dry, and then cut it off using snips. The bar can then be trimmed level with the edge of the fretboard using a nice sharp chisel **18**.

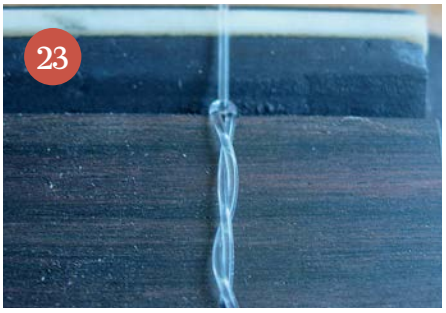
The nut and the saddle on this guitar are bone, so there's no need to replace them. The saddle needs reshaping, though, as it appears to be flat at the moment; it needs an angle of about 20 degrees on the top of it going down towards the tie block **19**. Use a sanding block, **20** and once you've achieved the correct angle you'll also need to round over the front edge of the saddle or it'll cut through the strings. Use the sanding block to ensure a straight edge, then polish with some 600 grit wet and dry.

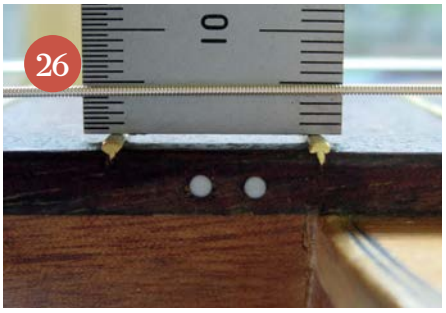
Now for the strings. With classical guitars, this is a whole











subject in itself. First, we'll put a little oil on the tuners – it may help keep them working for another 30 years (21). Let's start with the two E strings. Pictures (22) and (23) show how they are tied to the tie block: the wound strings are wrapped around themselves once and locked at the back of the tie block, but the treble strings – which have more of a tendency to slip – are wound around themselves twice before being locked at the back of the tie block, with the tension on the string holding it all place and stopping any slippage. At the tuning head end we have to do a similar thing (24). Put the string through the hole, then pull it back around itself; when the string is tensioned one gets locked under the other, and stays in place.

With the two E strings on, check the action at the 1st fret (25) and the 12th fret. At the first fret on the bass string you should be looking for a gap between the top of the fret and the underside of the string of about 0.7mm, and at the 12th fret for a gap of between 3.4mm and 4mm (26) depending on your playing and the type of string used (higher tension strings will generally play at a lower action; the more tension on a string, the smaller the circle it will vibrate in). On the treble string you'll again need about 0.7mm at the first fret and 2.7mm to 3mm at the 12th fret. Start off on the high side, as it's easy to lower the action, but to raise it you'll need a new nut and saddle. If the strings are too high, bring them down a little at a time from both ends. If you lower it right down at the nut then reduce it by a touch at the 12th fret, you will in turn lower it more at the first fret.

The good news: as the strings on nylon-strung guitars are all of a similar gauge, you'll only need one or two nut files. Hold the file at an angle of about 10 degrees to ensure the string is held firmly over the nut, and file down a little at a time (27). When you've done the E strings, put the rest of the strings on and adjust all the strings so that the tops are level (28).

To reduce the action at the 12th fret you'll need to slacken the strings off and remove material from the underside of the saddle. Mark the amount to take off with a felt tip and use the sanding block with a square fence; this will make sure the bottom of the saddle stays nice and flat (29). Once happy with the action you can finish the top of the nut to leave just half of the string protruding (30), and, when you pop the nut back on, add a touch of glue underneath to hold it in place. With nylon strings it's a good idea to tune them up to pitch and stretch them by pulling them away from the fretboard, tuning to pitch and repeating a few times until they stop slipping.

So a decent Spanish guitar has been saved from the scrapheap and is ready to place in a beginner's hands. Trouble is, a correctly set-up classical is such a nice thing to have around that you might be rather tempted to keep it for yourself...

22 Wound strings need just one wrap under

23 Treble string wrap. The plain ones need an extra turn

24 The 'locking' trick works works at the headstock, too

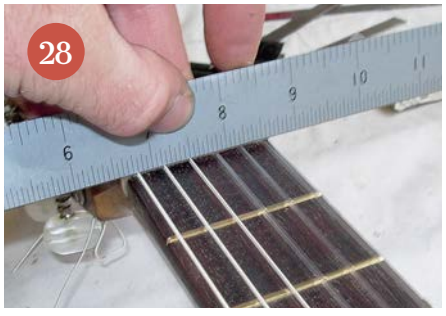
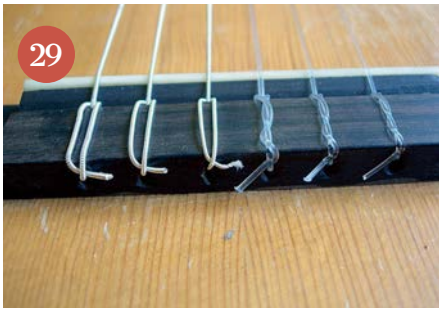
25 Where the action is. About 0.7mm is right at the first fret

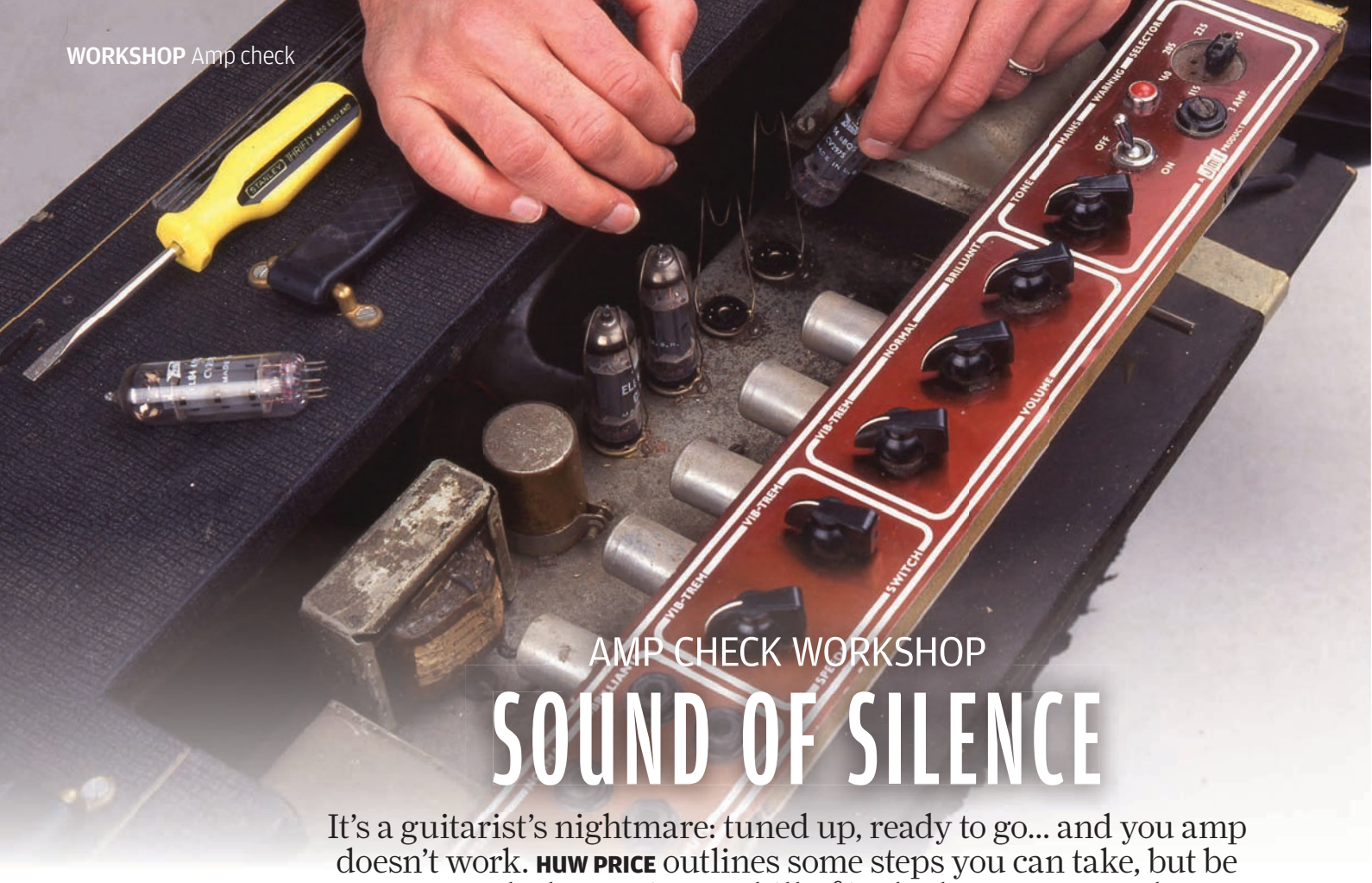
26 At the octave up to 4mm... higher than a steel string

27 When cutting nut slots remember that important break angle!

28 Make sure the string tops are level at the nut

29 All strung up. A properly strung bridge: no slippage

30 The finished nut. Note the slots are just half a string deep





AMP CHECK WORKSHOP

SOUND OF SILENCE

It's a guitarist's nightmare: tuned up, ready to go... and you amp doesn't work. **HUW PRICE** outlines some steps you can take, but be warned: electronics can kill. If in doubt, see your tech

All amps, eventually, go wrong. It's simply a fact of life. If you're lucky, it'll happen at home or in rehearsal; the electronic version of Murphy's Law dictates that it'll happen at a far more awkward, and public, occasion. Sometimes it's just a gradual deterioration in tone due to valves going beyond their sell-by date, resistors drifting off value, or capacitors becoming leaky. But, amps can also fail completely.

This article isn't about maintenance issues or tone tweaks; we'll be discussing what can you do when little or no signal comes out of the speaker. We'll draw up a check list that may allow you to figure out what's wrong with your amp and perhaps fix it yourself. Getting into the nitty gritty of component replacement goes beyond the scope of this article, but if you can figure out what's wrong, it may save your amp tech time, save you money – and maybe save the gig.

1 CHECK THE FUSES

Is the amp completely dead, with no pilot light and no orange glow from the valves? If so, the circuitry of your amp probably isn't seeing any electricity. First of all, check the fuse in the mains plug after removing it from the wall socket. You may need to take the back off the plug to do this if it's an old fashioned non-sealed type. Test the fuse with a multimeter and while you're in there, check that all three cables are securely connected to their respective pins.

Most amps will also have a fuse socket on the chassis, often in the vicinity of the mains input. Remove the fuse and test it. If it's blown, simply replace the fuse with another of the same rating. If that new fuse blows, you'll know for sure that something is wrong inside the amp. Replacing a fuse with a jumper connection is never an option. The fuse is there to protect you and your amp. If the fuse isn't the problem, you need to start substituting valves. Jump to item No 4!

The fuse: so obvious, but examine this first

2 CHECK THE RECTIFIER VALVE

If the pilot light is on, but the amp produces no sound – not even hiss or hum – there may be a problem with the rectifier valve. Many valve amps will have solid state (diode) rectification to convert AC into DC. If your amp does have a rectifier valve, the most common types will be labelled GZ34, 5Y3, 5AR4 or EZ81. Rectifiers can look very similar to power tubes so, if you're unsure, check your valve code on line to determine what type it is. The best way to troubleshoot your rectifier is to substitute it for an equivalent that you know is working.

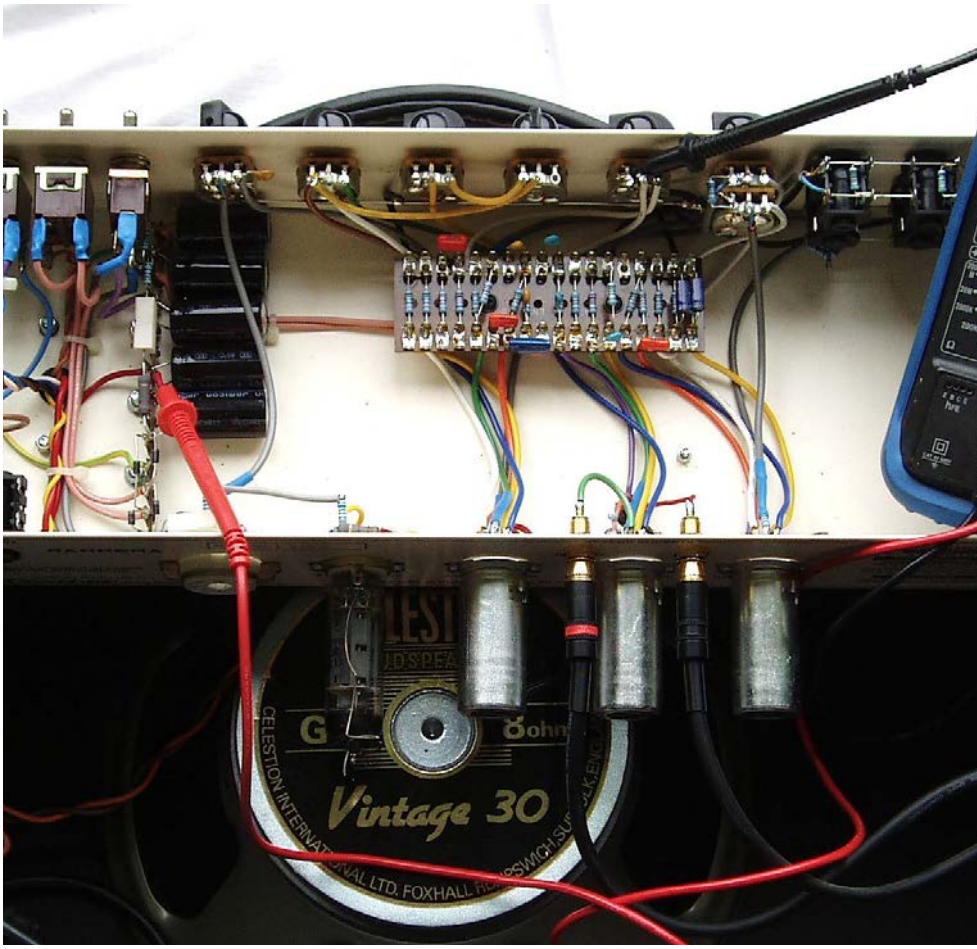
3 CHECK THE SPEAKER

Before moving onto the circuit board and the components, it's best to verify that the speaker is working. With your amp turned off, set your multimeter to its lowest resistance setting, unplug the speaker jack from the chassis and touch the metal probes to the tip and sleeve sections of the jack plug. You should hear some popping or crackling if everything is ok.

If there's no noise, try touching the probes against the positive and negative terminals of the speaker. Noise from the speaker would then indicate that one or both of the speaker cables is faulty, or maybe a solder joint has failed inside the jack plug. Use your eyes and your multimeter to trace the problem. If there's still no noise, the speaker may be blown. Try plugging your amp into a working speaker cab to verify this, then repair or replace the broken speaker.

Check the speaker both at the speaker jack and the terminals

4 IDENTIFYING FAULTY VALVES



Amps blow fuses when excessive current is being drawn. This can happen when a valve goes faulty, so substituting valves in known working condition may solve the problem of blowing fuses. Try removing all the valves, then switch the amp on. If the fuse blows, the problem isn't being caused by the valves – so jump straight to item No 7, over the page.

If the fuse doesn't blow, there a good chance that one of the valves is the guilty party. Turn the amp off, reinstall the rectifier valve, and switch on. If everything is fine, repeat the procedure with the power valves (one at a time) and rectifier valve installed.

Work your way through the amp, adding one valve each time until the fuse blows again. If you do identify which valve may be faulty, try swapping it with a verified equivalent. If the fuse still blows, it may not be that particular valve, but there's a strong possibility that the fault lies with one or more of the components within the vicinity of that valve socket. You might need several fuses to complete this section of our troubleshooting guide.

VALVE SWAPPING

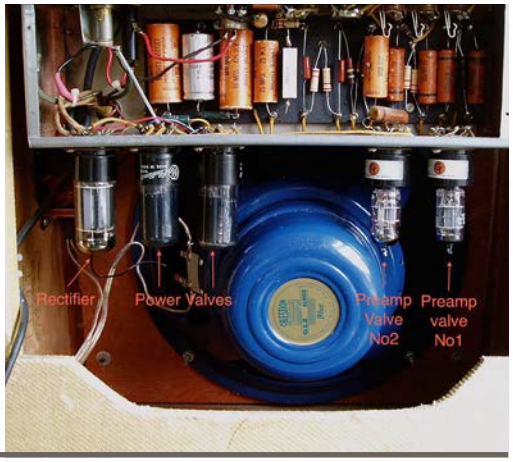
Old Fender amps, like this 1950s Deluxe shown on the right, had a very straightforward valve layout. The audio signal moves from the first preamp valve on the far right to the power valves on the left. The rectifier valve on the far right is located next to the mains transformer.

Amps often stop producing sound due to valve failure without blowing any fuses. Fortunately, valves are really quite easy to swap. Firstly, do a visual check. Are all the valves glowing orange? You may need to remove any metal covers and dim the lights to be sure. If one or more of the valves isn't glowing, there may be a problem. However, a valve may still glow even if it has stopped passing audio signal.

With the amp switched off, pull out a valve and replace it with an equivalent that you already know is working. Then simply work your way through all the valves one at a time, and if you're lucky your amp will burst into life as soon as the faulty valve is replaced.

Alternatively, put all the valves from your faulty amp into a functioning amp one at a time until the good amp suddenly stops working. If none of the valves causes the previously functioning amp to fail, then the problem with your amp is unlikely to be the valves.

One word of warning – valves get hot! If you can't wait for them to cool down, make sure you protect your fingers with an oven glove or something similar when you're removing them.



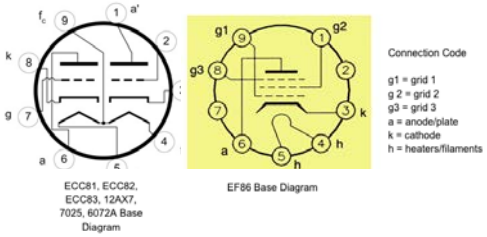
5 CHECKING THE HEATER AND PLATE VOLTAGES

The power supply section of every valve amp delivers a high DC voltage for the plates of the valves and a second voltage for the valve heaters (typically 6.3 volts AC). Assuming that a working speaker is properly connected and all the valves tested okay, it's time to test the internal voltages. Before continuing we should stress that this is the point where things can become dangerous.

Let's test the heater voltage first. Set your voltmeter to the appropriate scale – usually around double the voltage you're expecting to read – then secure the meter's negative probe firmly against the amp chassis and turn the amplifier back on. Hold the meter's positive probe in one hand and put your other hand in your pocket.

You must never touch the amp with both hands while testing circuitry. Doing so risks taking an electric shock across the heart, and that will probably kill you.

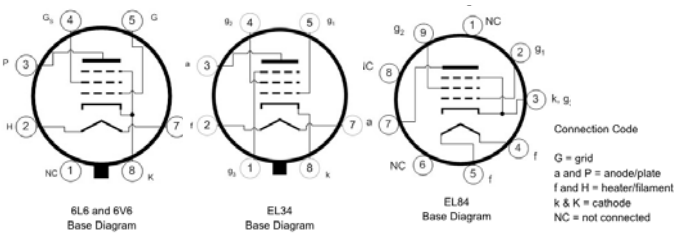
Typical Preamp Valve Connections



Here are the socket connections for the most common preamp valve types. The EF86 pentode has a different connection layout to the common double triode valves. This is the reason why you can't swap them without re-wiring the socket

Here are the socket connections for the most common power amp valve types

Typical Power Valve Connections



Still feeling confident? If so, bring that positive probe down onto the heater pins of one of the sockets of the audio valves and check that the meter reads around 6.3 volts. The heater pins will vary depending on the type of valve, so refer to the diagrams. We'd suggest verifying the heater voltage on one of the preamp valves.

The high voltage is applied to the plates (anodes) of the valves. Try to determine where you can measure the output voltage of the power supply section. Alternatively you can also take readings from the plates of the audio valves.

This is a little more complicated because the plates are usually connected via dropping resistors. If possible you should try to find a schematic or circuit diagram for your amp. Many of these will include target voltages at key points in the circuit. If you don't have this information, you should expect to read something between 160v and 260v on the plates of a preamp valve and between 350v and 550v on the plates of power valves.

If your readings fall somewhere within those areas, it doesn't necessarily mean that the voltages throughout the amp are correct. However it does suggest that the power supply section of the amp is working properly and that your mains transformer is okay. Always set the scale on your voltmeter so it's around twice what you'd expect the actual voltage to be.

6 POP TESTING

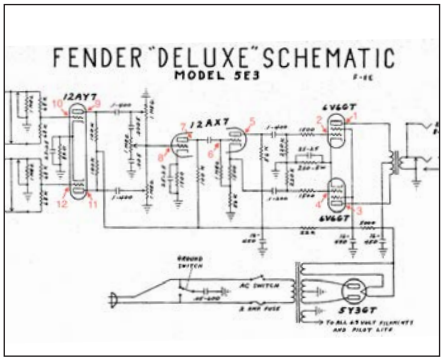
Don't worry; the 'pop test' isn't another competitive karaoke show from the malevolent mind of Simon Cowell. It's actually a simple and straightforward method for tracing faults in audio circuits, and engineers have been using it since the year dot.

The pop test is also known as the 'circuit disturbance test'. The idea is to work your way from the output stage to the input stage of your amp using a probe. You should hear a 'pop' or 'crackle' every time you touch the probe to a test point. As you work towards the input stage of the amp, these noises should get louder. As soon as you get to the point where the test noise gets quieter rather than louder, or disappears altogether, you'll have identified at least one of the problem areas.

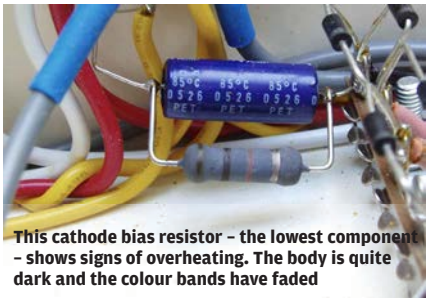
All the test points are on the valves themselves. By and large, audio signals enter the valve at the grid and exit at the plate/anode. So when you're pop testing, you need to touch the anode/plate first, then the grid – remember, we're working backwards. For a suitable probe, try using a small-bladed screwdriver with a heavily insulated handle. Again, keep one hand behind your back or in your pocket, and never touch any of the metal parts.

If your amp has inter-stage volume controls, they should be turned up slightly. It also helps enormously if you have a schematic/circuit diagram for the amp you're working on. Sometimes a schematic is provided in the instruction manual but if not, you can usually find one on line. You can actually do your pop tests at the same time that you're checking your HT/B+ voltages.

In this diagram you can see the sequence of the pop test points for a 5E3-type Fender Deluxe. If you understand the principle, you should be able to figure out the sequence for any amp if you have access to the schematic. If you don't understand the principle, then you almost certainly shouldn't be doing this sort of maintenance work just yet.



7 MAINS TRANSFORMER



This cathode bias resistor – the lowest component – shows signs of overheating. The body is quite dark and the colour bands have faded

When an amp comes in for repair, it's always best if you ask the owner what happened when the amp failed. Our *G&B* colleague Martyn Casserly seemed oddly relaxed when describing how the Master Volume control started making noises, then stopped working and 'a bit of smoke started coming out the back of the cab'. 'Burning' and 'smoking' can be complimentary terms used to describe amps, but when these characteristics become literal rather than figurative, you can be fairly certain that something of a pretty serious nature has occurred.

Excess heat and burning usually leave tell-tale signs on components, so opening up the amp and carrying out a visual inspection for burned or discoloured components was the best place to start. One of the resistors in the power supply looked discoloured to us – which is usually a sign of excessive heat (see picture). We didn't like the look of the cathode bias resistor either.

But more worryingly the mains transformer became very hot and this was accompanied by a burning smell. There was also a slight buzzing/humming noise that became louder as the transformer heated up. We let everything cool down, removed all the valves and powered up again. The result was the same – even with no load on the transformer.

We concluded that insulation inside the mains transformer had possibly failed and a new transformer may be required. However, we decided to replace the dodgy-looking resistors just in case. We used wire-wound resistors rated at 5W. Resistors are cheap and they were easy to install, so it was worth a try.

Unfortunately the transformer continued to overheat and mains fuses blew quite quickly, so at this point we decided that the Carrera amp should be turned over to a properly qualified tech. Knowing your limits is a good thing when you're dealing with dangerous voltages and expensive components.

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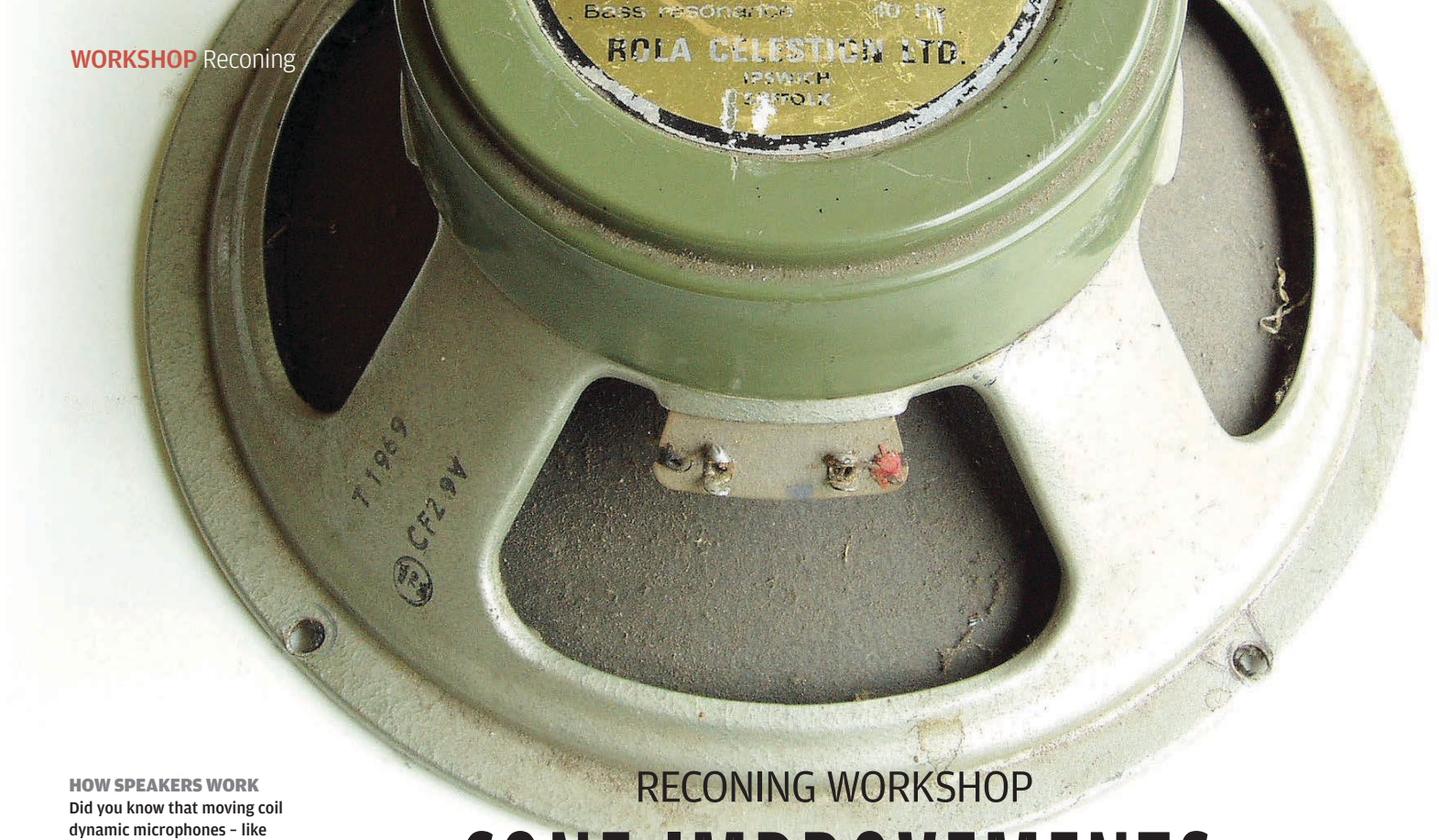


RECONING WORKSHOP

CONE IMPROVEMENTS

If you have a nice old speaker with a blown or non-original cone, you need to read **HUW PRICE'S** guide to fixing it yourself

HOW SPEAKERS WORK

Did you know that moving coil dynamic microphones – like Shure SM57s and SM58s – are actually speakers in reverse? Their basic construction is so similar that many studio engineers sometimes use Yamaha NS10 drivers as low-frequency microphones on kick drums and bass guitars. Both have diaphragms fixed to solid structures around their outside edges (plastic for the microphone, a paper cone for guitar speakers) which are in turn fixed to tubular coil formers wound with metal coils. The coil and former assemblies are inserted into a circular gap between the north and south poles of a magnet, and the built-in springiness around the edges of the diaphragm allow the coils to move forwards and backwards inside the magnet gap.

A mic transforms acoustic energy into to electrical energy that we can record. Speakers do the exact opposite – they turn electrical energy into acoustic energy. An alternating current from by a guitar amp is fed to the wire coil, which causes the coil assembly to move forwards and backwards. This in turn moves the speaker cone, which compresses air particles in front of it to form sound waves like the soundboard of an acoustic guitar.

Sooner or later most vintage amp owners will face a dilemma: what is more important... originality or functionality? It's a fact of life that capacitors go leaky, valves wear out, and speakers blow. This month we're going to figure out what can be done when those old speaker cones finally give out..

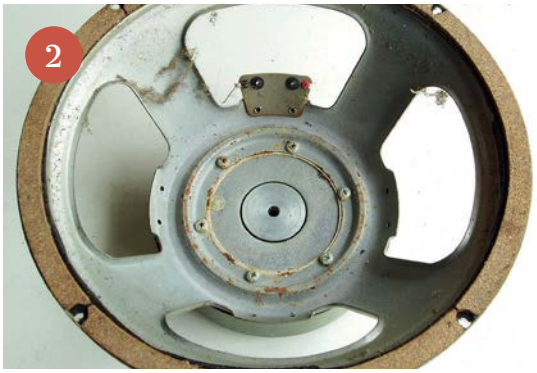
Guitar speakers have to take a lot of punishment. Many old amps are regularly cranked up louder than their designers ever intended, and the speakers are often pushed beyond their limits. This will take its toll, and even if they don't burn out or blow, many speaker cones will split or tear, especially around the edges. Most are made from paper, which doesn't last forever.

So what can you do when a lovely old Vox Blue, Celestion Greenback or Jensen becomes a liability? Some might advocate boxing it up for posterity and replacing it with a repro or a replacement from Weber or Tone Tubby. But what's the point in having an all-original but useless speaker stashed when you could re-cone it for another 40 years of service? You could do the recone yourself... and even change the impedance while you're at it.

Here, we have a go at repairing an old Celestion G12H Greenback. Thousands were made and there must be countless examples in various states of disrepair all over the country. If the date codes published on www.unclespot.com/celestion_date_codes.html are to be believed, ours was made on March 2, 1973. Celestion sells recone kits for most of its classic and current speakers, and G12 kits come in 8 Ohm and 16 Ohm versions.

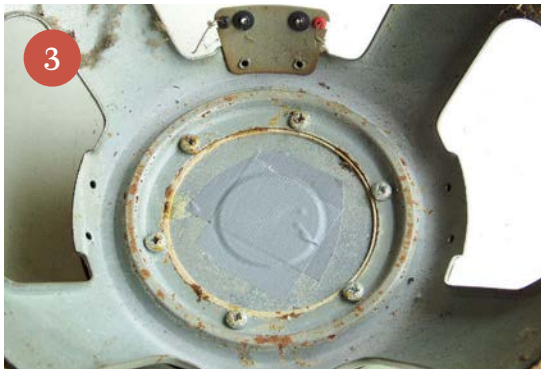
Emptying the basket

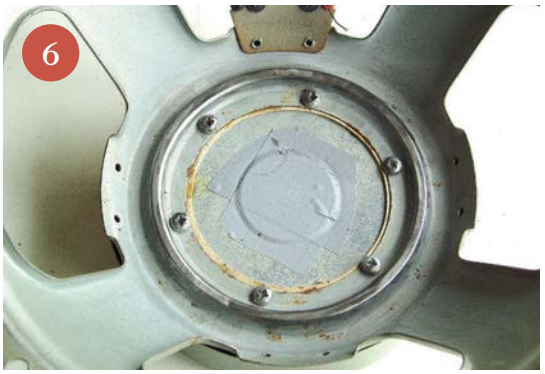
Our speaker was absolutely filthy, having sat on a shelf for several



1 This '70s Celestion G12H was in a terrible state – and a perfect candidate for a recone. This photograph shows how the spider had already become detached from the chassis

2 The cone has been removed, but at this stage the cork gasket is still in place





3 We put a couple of squares of gaffer tape over the gap to keep everything clean

4 Removing the cork gaskets isn't hard. We removed most of them with a wood chisel

5 Here's the basket after finishing off the cleaning with some acetone

6 A brass brush on a Dremel polished up the surface of the spider with good results

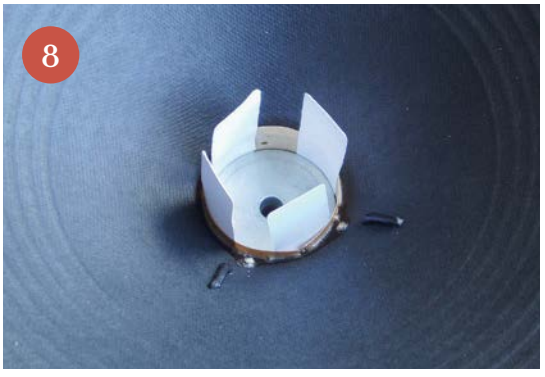
years. There were two holes in the cone and the spider had detached from its gluing surface all around its edge 1. Keeping everything clean is essential when you're reconing, and the gap for the voice coil has to be kept completely free of debris. I started by snipping the two wires and cutting around the top edge of the cone. I carefully lifted out the cone, spider and voice coil assembly 2, then immediately covered the voice coil gap with tape 3. It's essential to keep that gap as clean as possible; masking tape or gaffer tape will be fine.

Using a damp cloth, I wiped decades of dust off the metal basket, and set about the gluing surfaces. The outer edges of the cone are glued to the top of the basket, and a set of cork gaskets are glued on top. Some people cut these off with a Stanley knife, but I found it easier to gently prise off the cloth cone material and gaskets using an old chisel 4. It's hard work but it goes quite quickly, just as long as you're not trying to remove every last bit. To shift the old glue residue, brush on some acetone and let it soak for a few seconds before scraping any remaining material off the metalwork 5. Since the spider had already been blown off its surface, less cleaning was needed in that area. There was some surface rust, so I put a small brass brush on my Dremel tool and set about cleaning both gluing surfaces back to shiny metal 6. Brass is better than steel because any loose strands won't stick to the magnet. Alternatively you could use sandpaper, but be sure not to leave any abrasive particles behind.

Mind the gap

I've already mentioned keeping stuff from getting into the voice coil gap when you're preparing a speaker for a recone, but you've also got to clean out the gap. I started with a quick blow from a compressed air aerosol – just like the type that can be used for cleaning computer keyboards and relicing nitro cellulose finishes.

Next I took a thin strip of cardboard and a strip of masking tape and wrapped the masking tape over the end of the strip with the sticky side facing outwards. Take a little bit of the stickiness off the tape by pinching it a few times with your fingers or wiping it against your clothes, and then push the tape into the gap. The cardboard strip provides the necessary rigidity for the task, and you >



7 Cleaning the voice coil gap with acetone on a kitchen towel wrapped around some card

8 Centering shims are used to accurately position the coil former in the gap

9 The next stage: the centering shims are removed, ready for the dust cover'

10 The dust cap can be lowered into place using a sticky tape 'handle'

11 The final touch: new lead out wires are connected to the chassis terminals

should be able to carefully move the masking taped cardboard in a circular motion around the gap and pick up any lurking dust or debris. Perform this several times, and then repeat the process using kitchen paper soaked in acetone to wipe the surfaces of the gap **7**.

The dry run

Once you're confident that the gap is as clean as it could be, it's time to try a dry run at assembling the speaker. Make sure the lead out cables line up with the chassis terminals, and drop the voice coil into the gap. Celestion's recone kit includes four cardboard shims to help you to centre the coil former in the gap. Simply push these down in between the inside of the coil former and the inside edge of the gap **8**. If all goes well, you should be ready for the real thing.

Sticky moments

Glue isn't included with the kit but Celestion recommend a clear 'slow-setting' rubbery contact adhesive such as Bostik 1782 to stick the spider and cone to the metalwork. Now it's time to put this thing together. First apply a continuous bead of the glue to the area where the spider is fixed to the chassis, and then apply another bead all around the outside of the chassis for the edge of the cone. Allow the glue to sit for five minutes to let it go tacky and then, after ensuring the cables line up with the chassis terminals, slide the coil former into the gap using the centering shims to guide it home until the spider settles on the glue bead.

Eyeball the top of the cone to ensure it's centred, then press it down onto the glue. You can use one side of a disassembled clothes peg to work your way around the edge, and use your finger to press down the edge of the spider. The four cork gaskets should then be attached using the same glue bead method. Make sure the fixing bolt notches line up with the holes drilled into the outside edge of the basket. The gaskets should also butt up tightly against one another. Once they're in place, flip the speaker over onto a flat surface and allow its weight to press the joints together for a few hours while the glue dries.

Capping it off

Finally, remove the cardboard centering shims **9** and glue on the dust cap. The edge of the cap is angled to conform to the cone, so it centres up nicely. Place it correctly, then carefully draw a pencil line around the edge. Remove the dust cap, apply a bead of glue along the inside edge of the pencil line then, using a loop of masking tape as a handle **10** carefully position the dust cap onto the glue. You can use a shot glass or an egg cup as a weight while the glue dries. While you're waiting, heat up your soldering iron and attach the new hook up wires to the chassis terminals **11**. The job is finished, but do leave the glue to set for a day before hooking up the speaker.

Verdict

Besides being diligent about cleaning the coil gap, reconing a guitar speaker like a Celestion G12 is relatively easy. Unless you're able to get a discount by buying recone kits in bulk, it probably isn't going to save you much money – but it only takes an hour or so, and it's a lot of fun. I'm planning to do the same to an old Jensen and a pair of Elacs, and I can't wait to hear what they sound like.

SPEAKER COMPONENTS

BASKET
The metal chassis of the speaker that all the parts are attached to

CONE
Guitar speaker cones are usually made from paper (aluminium has some followers among bass players). It's often be dead straight, but sometimes its flared. Earlier designs are often smooth but later designs are ribbed to increase stiffness and tighten up the bass response. The edge of the cone is glued onto the basket, and this is what moves to produce the actual soundwaves

COIL ASSEMBLY
A tube or cylindrical 'former' that is glued onto the inside of the cone's base. This forms a rigid structure for the magnet wire wound around its outer surface

SPIDER
A flexible cloth membrane that's glued to the outside of the cone's base then glued to the base of the basket. The spider helps to centre the coil in the magnet gap and forms a barrier against debris

MAGNET GAP
The circular air space between the annular pole and centre pole of the magnet assembly where the coil assembly is inserted

DUST CAP
A dome of paper or fabric that's glued onto the base of the cone to keep debris out of the magnet gap

CHASSIS TERMINALS
These are the positive and negative terminals where the speaker wire that comes from the amplifier's output transformer is attached to the speaker

Celestion G12 Recone Kit supplied by Celestion

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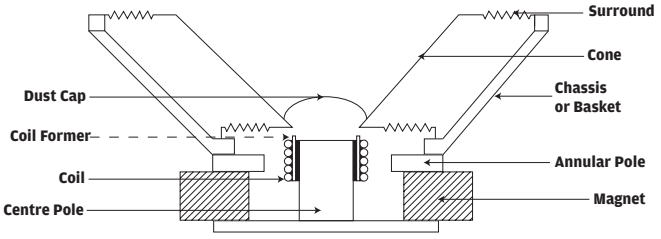

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1

PREAMP PROJECT

SHURE THING

How about the prospect of four classic-sounding microphone preamps for a mere £50 or so? **HUW PRICE** shows you how to turn the venerable and commonly-available Shure M67 four-channel mixer into a phat front end for your recording setup

1 Built between 1968 - 1988, the Shure M67 has gained a bit of a reputation in vintage audio circles. With a few changes, it can be transformed into a mic preamp that'll add warmth and depth to home recordings of vocals, electrics and acoustics, basses or even drums

2 Here are the four original input transformers with circuit input connections on the left edge of the board, shown prior to our cunning relocation

3 This shot shows the gain controls and high pass filter capacitors of the stock unit. We're going to shift these gain controls back up the signal chain, putting them after the input transformer

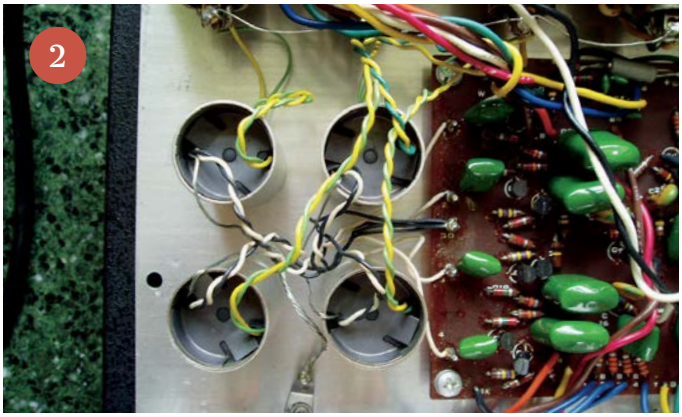
Many of us have home recording setups, but few have the facilities to record a live band or even a drum kit. Even if we have enough microphones, the usual problem is that we haven't got enough mic preamps. Most semi-pro mic preamps/digital interfaces only have a couple of mic pre's; the spares are for line level signals. Interfaces with multiple mic pre's tend to be expensive, while the sonic quality of budget units is frequently indifferent..

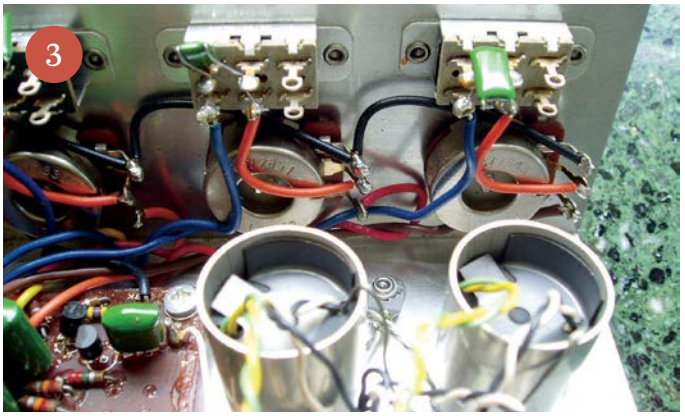
If you're up for a bit of soldering, though, you could modify a vintage Shure M67 four-channel mic amp/mixer, obtainable for around £50. We picked up a 240v version for £30 from an online auction, and set about the conversion.

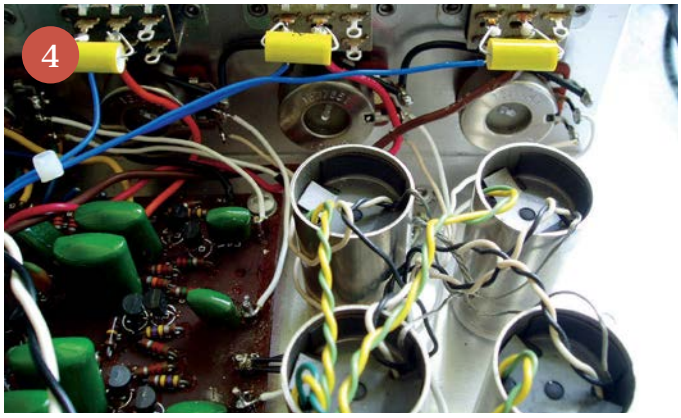
The Shure M67

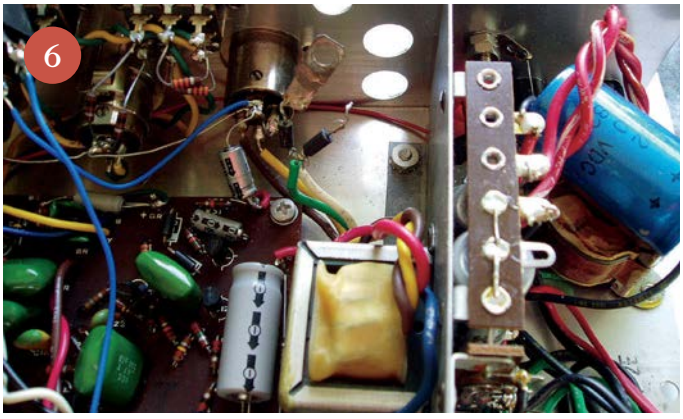
Shure made the M67 for 20 years, so they're plentiful. Eddie Kramer even used them to record Woodstock festival, and the basic circuit never changed. We're dealing with old school discrete electronics, so you won't find any microchips or op amps – just four proper mu-metal input transformers and a bunch of transistors and carbon comp resistors. This is the stuff that causes modern makers to wax lyrical in their advertising, and charge you a premium.

The stock design routes all four mic inputs to one output via a shared second gain stage, as M67s are actually mono mixers. We'll show you how to reconfigure the circuit for individual outputs. We'll keep the second gain stage on channel 4, and relocate the gain control to help the M67 cope with high-level sources like electric guitar and drums. Lastly we'll be adding switchable phantom power so the M67 can interface with









modern condenser microphones.

Gain control

The stock M67's input transformers (2) bump up the gain, which feeds straight onto the transistors – great for fuzztone, but useless for recording cleanly. The fix: move the gain control from after the transistor gain stage (3) to a position between the input transformer and the transistors (4). Channel 4's transformer wire will need to be extended to reach the gain controls, but that's very simple.

Here's how to do it. First, each gain control has an orange wire leading from the centre tag to the centre tag of the Lo-Cut switch: remove them all. Secondly, there are four wires leading from the circuit board to the bottom tag of each control – brown (1), red (2), orange (3) and yellow (4). Disconnect each one from the potentiometer and reconnect them to the now vacant centre tags of the corresponding Lo-Cut switches.

Thirdly, there are some white cables connecting the outputs of the transformers to the circuit board – they're labelled, so reading from the back of the chassis to the front the order is 1, 2, 3, 4. De-solder these from the board and reconnect them to the bottom tags of the gain controls. Finally, solder fresh cables between the centre tag of each volume control and the relevant input tags on the circuit board where the input transformers were originally connected.

Individual outputs

The M67 has some unusual and unnecessary features (5) so to clear some space, we disconnected the headphone output (6). It's easy to do – the connections are tied onto the green and white cables that lead to the Line Out connections. We'll reuse this socket for output 1.

The line outputs are loudspeaker-type connections... hardly compatible with modern wiring conventions. Disconnect the brown and yellow cables from pins 2 and 3 of the mic output XLR, cover the ends with heat-shrink, and replace them with the green and white cables that are connected to the line outputs. These come from the output transformer, so output 4 will be transformer-balanced. When the line output terminals are removed, the holes are the right size to accommodate TRS jack sockets for outputs 2 and 3 (7) & (8).

Going back to the first three channels, on the circuit board between gain controls 3 and 4 you'll see four 33K resistors with three orange bands labelled 1-4 (9). This is where the individual input stages join the shared mixer stage via blue cables leading from the Lo-Cut switches.

We're going to retain the extra gain stage on channel 4, so leave that blue cable intact. The three others can be snipped off close to the circuit board. De-solder the other ends of the blue cables from the Lo-Cut switches and install longer cables that will reach from the switches to the tip connections of the individual output jacks we installed earlier. The ring and sleeves should be connected together then connected onto the ground wire running along the top of the XLR sockets. This will provide three pseudo-balanced outputs for the lowest possible noise levels, and you will be able to use balanced cables to connect to your digital interface.

Phantom power

M67s were designed to run on battery power as well as mains. What's more, one mains-connected M67 could be used to >

(4) The gain controls and high-pass filter capacitors post-modification. We chose to use a different value cap on the switches: see Bass Roll-Off

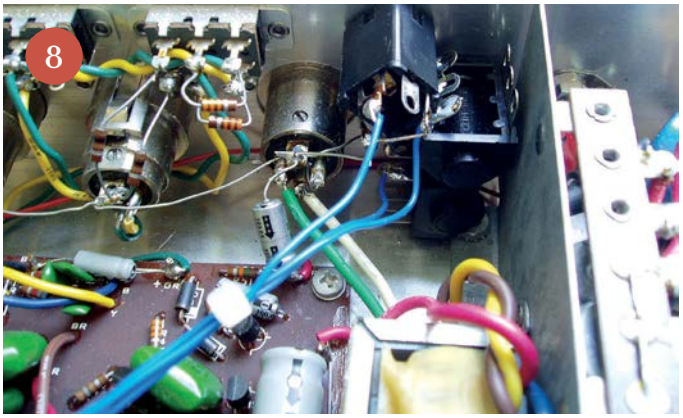
(5) The Shure's original output connectors are, frankly, no good for the likes of us. We're going to clear this lot out and make some space

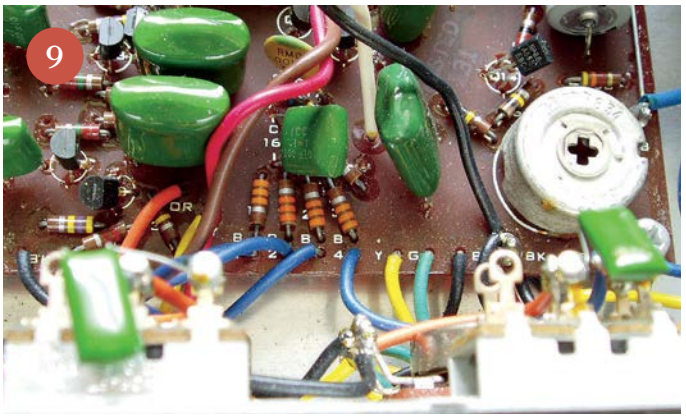
(6) At the top of the picture you can see the three holes that remain after we removed the Shure's original headphone and line out connections

(7) Ah, that's better. Two new output sockets have been installed along with a switch for the phantom power – useful for protecting ribbon mics

PARTS LIST

- **8 x 6.8K resistors**
- **4 x 68mF electrolytic capacitors (axial)**
- **Mini toggle switch**
- **2 x TRS jack sockets**
- **4 x 0.1mF to 0.2mF audio grade (axial)**





8 It's all taking shape. This photo shows the new output connection wiring, as seen from the inside of the chassis

9 Here are the four 33k resistors where the individual inputs join the mixer stage. Note the three bands of orange on each one

power two more M67s using the 30v terminals on the rear panel 10. So that redundant 30v supply can be used for phantom power.

Although 48v is the nominal power supply for condenser mics, many will run on lower voltages, as not all mixing desks provide the full 48v. Phantom power will come on at power up, but if you like to use ribbon mics, a phantom on/off switch is a wise option. Next to the power cord there's a screw terminal labelled 'Ground'. It's not connected to anything, so we can remove it and widen the hole with a drill bit or cone cutter to accommodate a phantom power switch.

You can simply solder a cable onto the positive terminal of the 30v supply and route it to pins 2 and 3 of each XLR input via pairs of 6.8Kohm resistors and four 68mF electrolytic capacitors. If you decide to fit a switch, solder the 30v feed to the centre pin then attach the phantom power cable to the top or bottom lug.

Bass roll-off

I decided to keep the switchable bass roll-off because many mics that are commonly used for guitar, like the Shure SM57, don't have bass-cut switches. Some budget condensers are the same, and a phenomenon called the proximity effect can make the bass sound boomy and muddy.

I found the stock 0.022mF capacitors a little over-zealous. The manual seems to indicate a corner frequency of around 350Hz and since our acoustic guitar test recordings sounded thin and unnatural, I decided to lower the corner frequency to around 100Hz. The roll-off capacitors are wired directly onto the Lo-Cut Filter switches on the front panel so they're easy to get at; simply remove the originals and replace them with values of your choice. Various websites have the formula to calculate the exact capacitor value needed to hit any chosen frequency, and after crunching some numbers we determined that we needed a cap value between 0.1mF and 0.2mF. Feel free to experiment; the best value will depend on the input impedance of your digital interface as well as your chosen mic. Remember that the capacitor is in the signal path, so use audio quality replacements.

Channel 4 gain

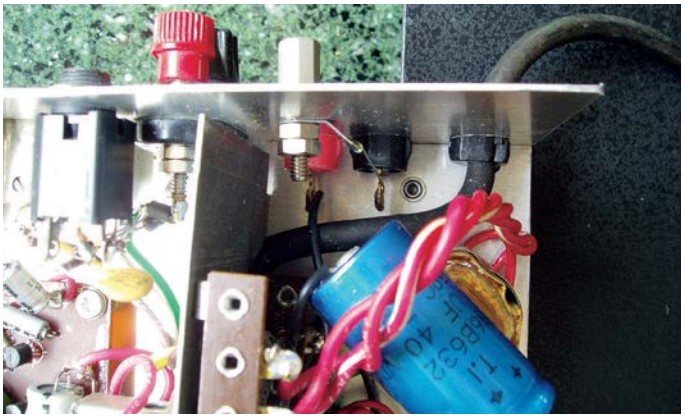
Although the first three channels have plenty of gain for electric guitar, bass, drums or any other loud source, they're a bit marginal for quiet sources. You can get away with close mic'ing a strummed acoustic, but delicate fingerpicking isn't really an option. So that's why I left channel 4 feeding into the mixer gain stages, giving enough gain for just about any application.

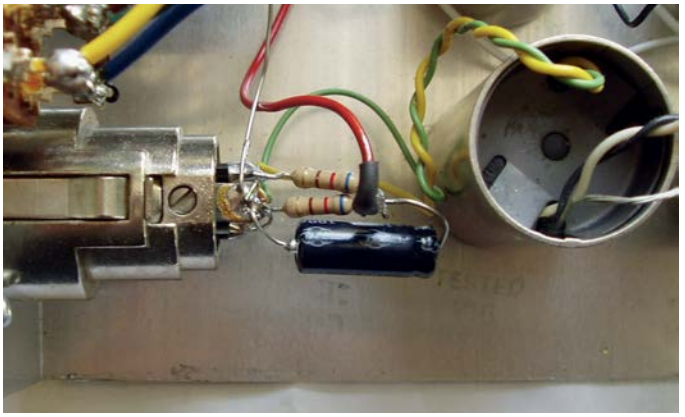
Verdict

This simple project won't cost you much money, but the best bit is that this Shure M67 sounds phenomenal. Many of the sonic characteristics of records from the analogue era are attributed to valves, but transistor mic preamps like early Neves, Tridents APIs and so forth really were just as important. The M67 sounds just like you'd hope an all discrete vintage mic preamp would sound – fat, chewy and larger than life. Even the noise levels are pretty low, and any slight hiss when you're pushing the high gain channel just adds to the retro vibe. Best of all, it sounds incredible on acoustic and electric guitars!

10 Above left you can see a redundant red 30v terminal with the ground tag above it. We're going to use that terminal to provide our phantom power

11 Phantom power parts with two high-tolerance 6.8k resistors feeding XLR pins 2 and 3 with a cap between the resistor junction and the XLR pin





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MIC UPGRADE

MOD YOUR MIC

Can a £150 condenser mic be upgraded to a level equivalent to a £1000 mic? We think so. **HUW PRICE** shows you how to build the valve mic that your acoustic and electric guitars deserve

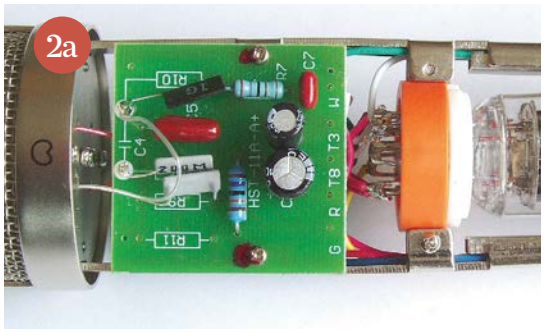
The reason many Chinese condenser and ribbon mics look and sound so similar is 'badge manufacturing', which has always been a feature of the industry. Neumann, Schoeps and AKG all made mics for Telefunken, Phillips and many others. Even the '59 Les Paul of vintage microphones, the ELA M251, was badge-manufactured for Telefunken by AKG. .

For this workshop (see pic 1 for what the finished articles look like and pics 2a and 2b for what the mic looked liked pre-modding) we're using a nine-pattern valve mic called the HST-11a, bought new on eBay for £149. It's made by Alctron Electronics in China (www.alctron-audio.com) but sold under many brands: Carvin CTM100, Apex 460, Nady TCM-1150, Harper Diabate HDV-1, Peluso P12 and Telefunken USA RFT M16. The Peluso and Telefunken have upgraded capsules, valves, transformers and circuitry, but most of the others are stock, with different colours and logos. Prices: £150 to more than £1200. The Alctron HST-11a is a decent mic, probably the most popular for DIY work. Starting with the easiest and cheapest, we'll work through the common modifications, assessing their impact.

Mod 1: Valve Swap

The HST-11a resembles the legendary AKG C12. The C12's preamp/impedance dropping circuit was designed around a 12AY7 valve, and the HST-11a was specified with a similar 12AT7 (ECC81). However, 12AX7 tubes are cheaper than 12AY7 and 12AT7 tubes; this is why Alctron installs 12AX7s, which have a gain of 100mu (a 12AY7 is around 44mu, a 12AT7 around 60mu). This extra gain can overload the transformer when used on loud sources like electric guitars, so there's a lack of clean headroom. Cheap Chinese 12AX7 microphones can also be noisy, and the two things you least want from a recording mic are noise and distortion.

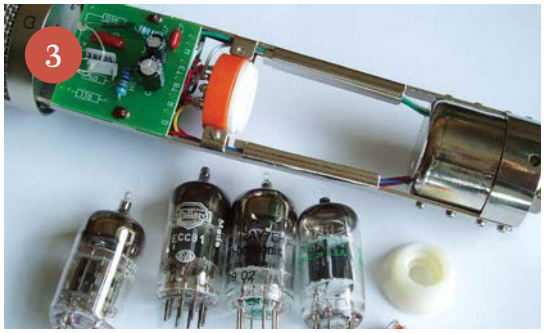
The GE 12AY7/6072 as used in the original AKG C12s are now very

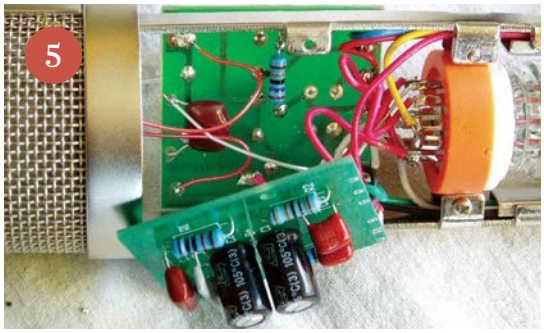


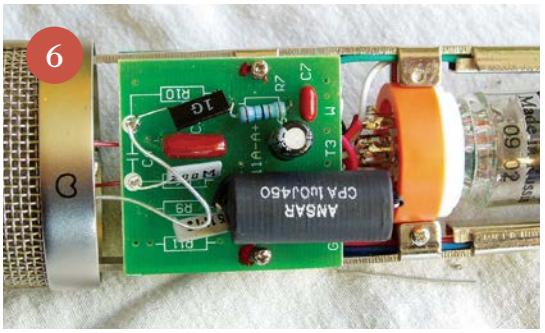
1 After all the upgrades we're going through, we thought it should look the part as well. The base and grille were nickel-plated, and the body and power supply got a vintage-style hammered paint

2a All the components are clearly labelled on both circuit boards. It does make things straightforward, but be gentle when removing components, including the valve

2b Here's how our microphone looked on the outside before the mods. Much the same unit is available under various manufacturer names, including Carvin, Apex, Nady and Harper Diabate







3 We tried a whole selection of valves, including a Mullard and an expensive NOS General Electric. We found that, taking everything into account, the £12 Electro-Harmonix 6072A won the contest

4 Most mics' pop shields have three layers of mesh. You can improve the response – but increase likelihood of interference – by carefully breaking the solder joints and remove the inner layers

5 In order to get our new, bigger C8 capacitor in – see pic 6 – we first needed to relocate R8 back to the rear of the circuit board

6 It's a very tight fit, but we found we could fit our new Ansar Supersound capacitor in lengthways. This made a huge difference to our budget mic

expensive. Fortunately the Electro-Harmonix **3** version is well-regarded, so we got one for £12. We also tried an E-H 12AT7/ECC81 and a GE 5751, which is like a low-gain ECC83 with an amplification factor around 70mu.

The valve is held in place by a plastic spacer with a sprung receptacle for the pointy bit at the end of the bottle. Push the plastic base against the valve, prise up one edge, slide it sideways to clear the transformer housing. Pull out the valve, and reverse the procedure to fit the new one.

Next, we tested the results on acoustic and voice, taking care to maintain mic placement and allowing each valve to warm up for 10 mins. The stock 12AX7B was muffled, indistinct and grainy, with a honky midrange. The ECC81 was clean and bright, but bland. The 5751 was slightly softer at the top and smooth in the midrange – better, but a little lean in the low mids and bass. The winner: the Electro-Harmonix 12AY7/6027A (see pic 3) for its bass depth, rich mids and sparkly highs.

Mod 2: Capsule Grille

A capsule housing has three layers of wire mesh – two thick mesh layers sandwiching a much finer layer. Most modders agree that this is one or two layers too many. The inner layers can be removed, with care, because they're only tack-soldered in place. Two small screws attach the grille housing to the main body of the mic. We freed the housing, gently lifted it clear of the capsule, and pushed a thin flat-head screwdriver between the inner and middle grille layers to prise the innermost layer upwards. A bit of persuasion will break the solder, and you can pull the mesh out from under the rim using a pair of needle-nose pliers. Once it was removed we tack-soldered the fine mesh back into position with a powerful iron and filed any sharp bits of metal smooth.

This mod produced a noticeable improvement in detail and openness, clearing up the midrange. When we removed the fine mesh things got even better – but removing layers might make the mic susceptible to interference and wind blasts, so a pop shield will be essential for vocals **4**.

Mod 3: Capacitor Change

There are only two capacitors in the direct signal path: C4 and C8. C4 is rated 1000pF and connects the capsule backplate. In some HST-11a variants this will be ceramic, and it's worth changing to polystyrene or polyester. In our mic the C4 – hidden on the rear of the front circuit board – was polyester, so we left it alone.

The C8 is of greater concern. It's a 1mF electrolytic, and most engineers agree that electrolytics aren't great for audio. The space inside the HST-11a is limited, so Alctron use small, high-capacitance electrolytics. A value of 1mF or above is needed to pass all the bass frequencies. The Ansar Supersound capacitor we used had to be installed lengthways, which meant moving R8 (270Kohms) to the rear of the circuit board **5** **6**.

Installing the Ansar made a big difference, almost eliminating the honky midrange and producing a smoother, more balanced and natural tone. There was a little less low-end weight, but the Ansar was nevertheless a huge upgrade.

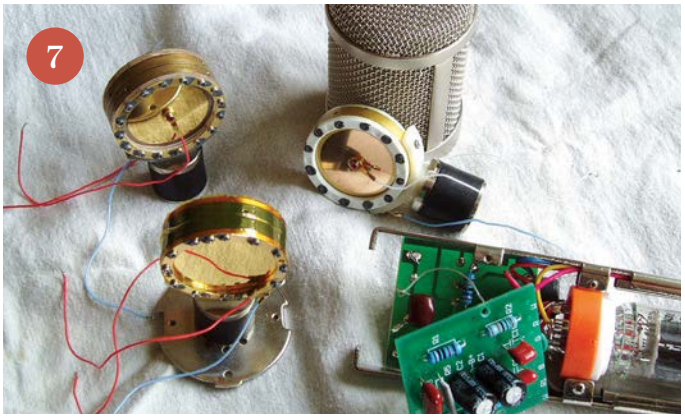
Next, the 100mF capacitor labelled C6. Given the value, we had to stick with an electrolytic, so we installed a legendary Black Gate branded cap. This made an even bigger difference than changing C8, restoring and even improving the bass depth and fattening up the low mids. By this point the microphone was starting to sound pretty good – but it was just about to get a whole lot better.

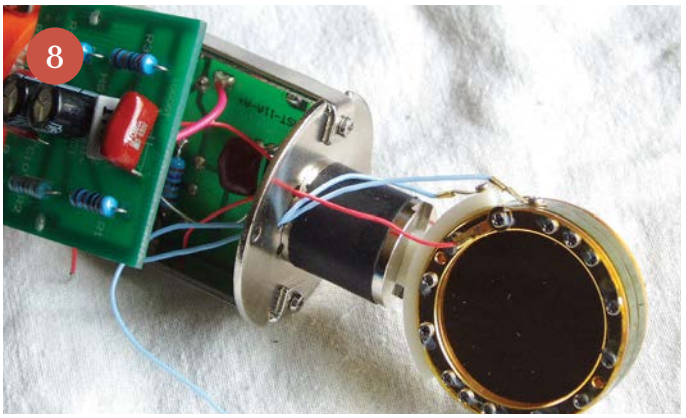
Mod 4: Capsule Swap

Capsules are to mics what pickups are to guitars. We're all accustomed to the benefits of upgrading pickups, and mic capsules – which are easy to buy – are no different. Now, most Chinese capsules are based on the 1950s Neumann-designed K67, originally used in the U67 and still living on in the U87. This was engineered with a treble boost to be matched with a treble-reducing preamp >

PARTS LIST

- **Mic: £150 from eBay**
- **Ansar Supersound 1mF capacitor: £2.50 from CricklewoodElectronics**
- **Black Gate 100mF capacitor: £1.71 from HiFi Collective**
- **6072a/12AY7 Valve: £12 from Watford Valves**
- **Peluso CEK-12 capsule: £155, KMR Audio**





7 A selection of Peluso capsules, all of which were an improvement on the original

8 Here's our favourite choice of capsule, the CEK-12, installed and ready for assembly

circuit (this treble pre-emphasis/de-emphasis arrangement is similar in principle to the RIAA curve used for vinyl records and the EQ curves used for analogue tape machines). Most Chinese condenser mics combine these trebly-sounding capsules with flat-frequency response circuitry, which is why they often sound too bright and harsh. Alctron capsules usually have a frequency spike at around 2.7KHz, 7KHz and a rise in response between 8KHz and 16KHz. What's more, quality control isn't exactly rigorous. Neumann's earlier M7 and K47 capsules didn't have the treble pre-emphasis, making them a better match for the flat-response Chinese preamps.

Peluso capsules **7** (www.pelusomicrophonelab.com) are great value for money. Peluso buys its metal parts from China but the gold-sputtered diaphragms come from Germany and all the crucial diaphragm tensioning and assembly work is done at their own facility. Peluso's UK distributor KMR Audio provided three capsules for us (see pics 7 and 8): an edge-terminated CEK-12 based on the original AKG CK12 capsule, a CEK-47 based on the old PVC-style Neumann M7 capsule, and a P-K47 based on the Mylar-diaphragm Neumann used in the later FET U47s.

Three wires from inside the capsule housing are soldered to the circuit board. Note the positions, de-solder the wires and remove the capsule housing. Release the two screws holding the capsule base plate to the body of the microphone and slide the assembly clear. Two screws fix the capsule riser clip to the base plate. Remove the stock capsule assembly and reverse the procedure to install the new one. Never touch the fragile diaphragm, and always ensure the housing is protecting the capsule when you're soldering; hot solder and resin can destroy it.

The deficiencies of our stock capsule were clear: a noticeable high frequency lift and a whooshy, smeary quality in the presence region. The CEK-47 had a much smoother and more filled out midrange, with a touch more bass. The highs possessed a bit more tinsel than we'd expect from a vintage Neumann, but it was a step forward in quality. The P-47 had the rolled-off highs we'd expect from a vintage Neumann along with solid lows and an ultra-warm, richly textured midrange. The CEK-12 **8** combined the best of both with tight bass, sparkly detailed highs and a full but less exaggerated midrange. All three were a big step up in quality and actually a very cost-effective way to put a HST-11a into a higher league.

Mod 5: Cathode Follower

The HST-11a circuit differs from the C12/M251 circuit it's loosely based on because both sides of the double triode valve are used, not just one side; the second half becomes a cathode follower to lower the output impedance of the circuit. The designers probably decided on this because it places fewer demands on the output transformer, allowing the use of cheaper items. However, most reports state that the HST-11a has an industry standard 10:1 ratio transformer, which rather negates the purpose of the cathode follower.

Many modders remove the cathode follower altogether and take the audio output to the transformer from Pin 1 of the valve via C8. It's fiddly but really quite simple; just remove R8 along with the wires connecting Pins 6, 7 and 8 to the circuit board. Solder a link wire to join Pins 6, 7 and 8 to Pin 9 (ground) then move the C8 connection from where it previously joined R8 to Pin 1 of the valve.

This mod produces mixed results. The output level dropped and some of the presence was lost, but the midrange became softer and smoother. Removing circuitry is always an attractive option, but improvements were marginal with the stock transformer (which many consider to be pretty decent, anyway). Cathode follower removal would make most sense if you simultaneously upgraded the output transformer with a Cinemag CM-2480 or a Peluso.

Conclusion

Much of the modding info on the internet is ill-informed, contradictory and/or dangerous. We wanted to sift through everything and present you with the mods we consider worthwhile. Be realistic, however, and bear in mind this is similar to fitting posh pickups, a steel trem block and quality pots to a Mexican Strat; whilst it may improve the quality of the guitar from 'pretty good' to 'very good', it will still sound like a Strat.

We compared our modded HST-11a to a vintage Neumann CMV563, a Telefunken USA ELA M250F and modern valve mics like the SE Z5600a II (£499), M Audio Sputnik (£379) and the Oktava MKL5000. Our HST-11a is as good as the £500-£600 mics, maybe better. It has a pure, impressively detailed sound of its own that falls between the Neumann and the Telefunken. It can't match the Telefunken's high frequency sheen and it's not as deep and velvety-sounding as the Neumann, but for an outlay of around £325, it runs them surprisingly close.

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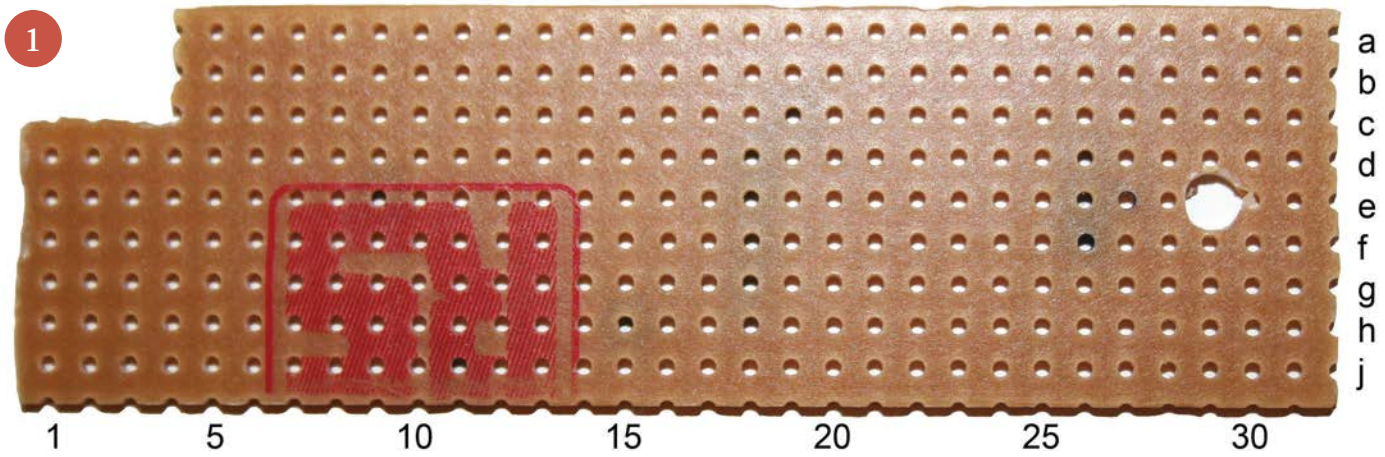
HEADPHONE AMP PROJECT

POCKET ROCKET

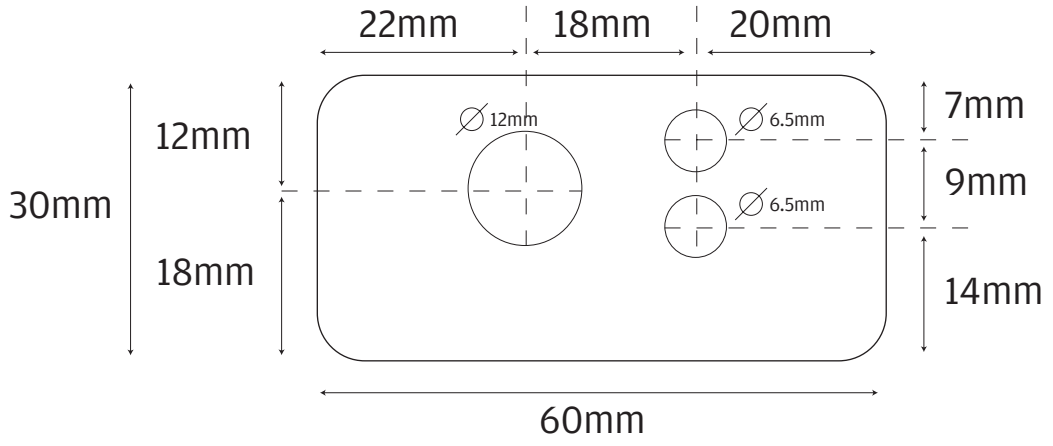
Smart phone apps are great but sometimes nothing but analogue tone will do. This little headphone amp offers an old-school alternative which you can build yourself. **DAVE PETERSEN** is your guide

A useful feature of many modern small practice amps is the headphone socket that allows you to play at a self-satisfying level without alarming the civilian population. Most of us have smart phones these days and many have splashed out on apps and their various attachments that offer a staggering array of guitar tones on the go, but sometimes there's just no substitute for pure analogue tone. So in this article we're going to tell you how to build an analogue gadget that will boost a guitar or medium-impedance microphone to a more-than-healthy level in your cans. It fits in your pocket, accepts a standard guitar jack cable and feeds standard headphones from its 3.5mm stereo phone socket. Powered by two low-cost AA's, standard or rechargeable, it'll play

1 Stripboard: cut to size and with a key for you to follow



POCKET ROCKET DRILLING DIAGRAM



for at leasst 100 hours or more.

The Pocket Rocket isn't a kit there's no special printed circuit board, so we're going to tell you how to build it with parts you can buy yourself for around £28. The parts list is based on Maplin parts and components.

There's not much space in the box, so finding a small enough volume control isn't straightforward, either to source or to fit. Instead we've used a mini switch... one way for ordinary guitar level, the other for microphones or loud guitar levels (take care of those eardrums, people!). The tone stays clear with low guitar volume settings, so this is a practical solution to the problem of not having a conventional volume control.

This gadget will boost a guitar or mic to a healthy level in your cans and it'll play for 100 hours or more

Building the pocket rocket

Begin by using the drilling diagram (above) to place the drilling centres in one end of the plastic box. Use a 3.5mm bit to pilot out the holes, and drill as accurately as possible to the template. Widen out the jack hole to 6.5mm and then to 12mm with a tapered reamer or a round file. The switch and headphone jack are both drilled out to 6.5mm final diameter.

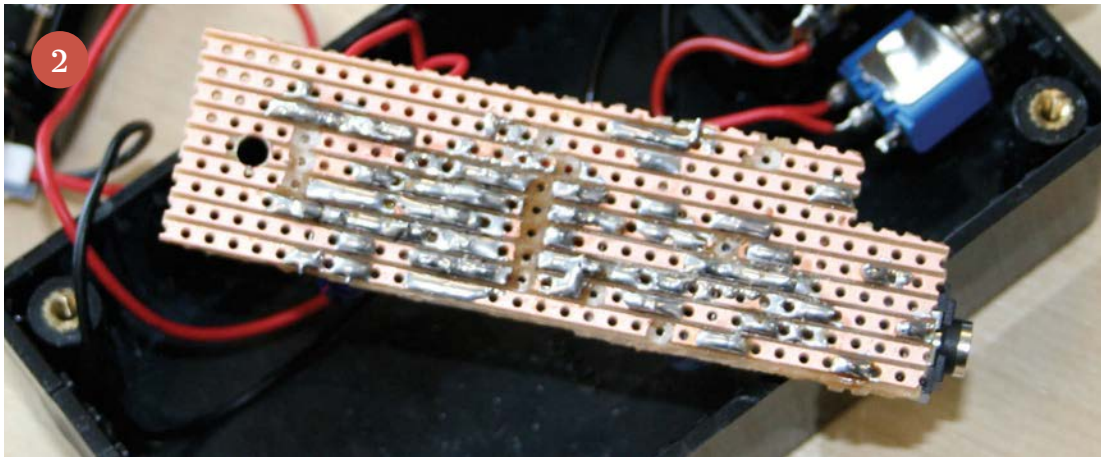
Now, let's prepare the stripboard. We've specified a piece that can provide two boards in case of unrecoverable errors the first time! Refer to the picture with the strip and hole numbering at the bottom of page 126 (1) and score both ends of strip 10, where you want it to break. Carefully bend along the strip until a crack appears at one end. Gently increased pressure should cause the crack to follow the strip in a straight line to the other scored end.

All being well, your final board size should be nine full strips across and 31 holes long. The 39-hole board is broken across the 32nd row to get the right length. The rough edges can be filed smooth to reduce the width for a comfortable fit. Using a pair of >

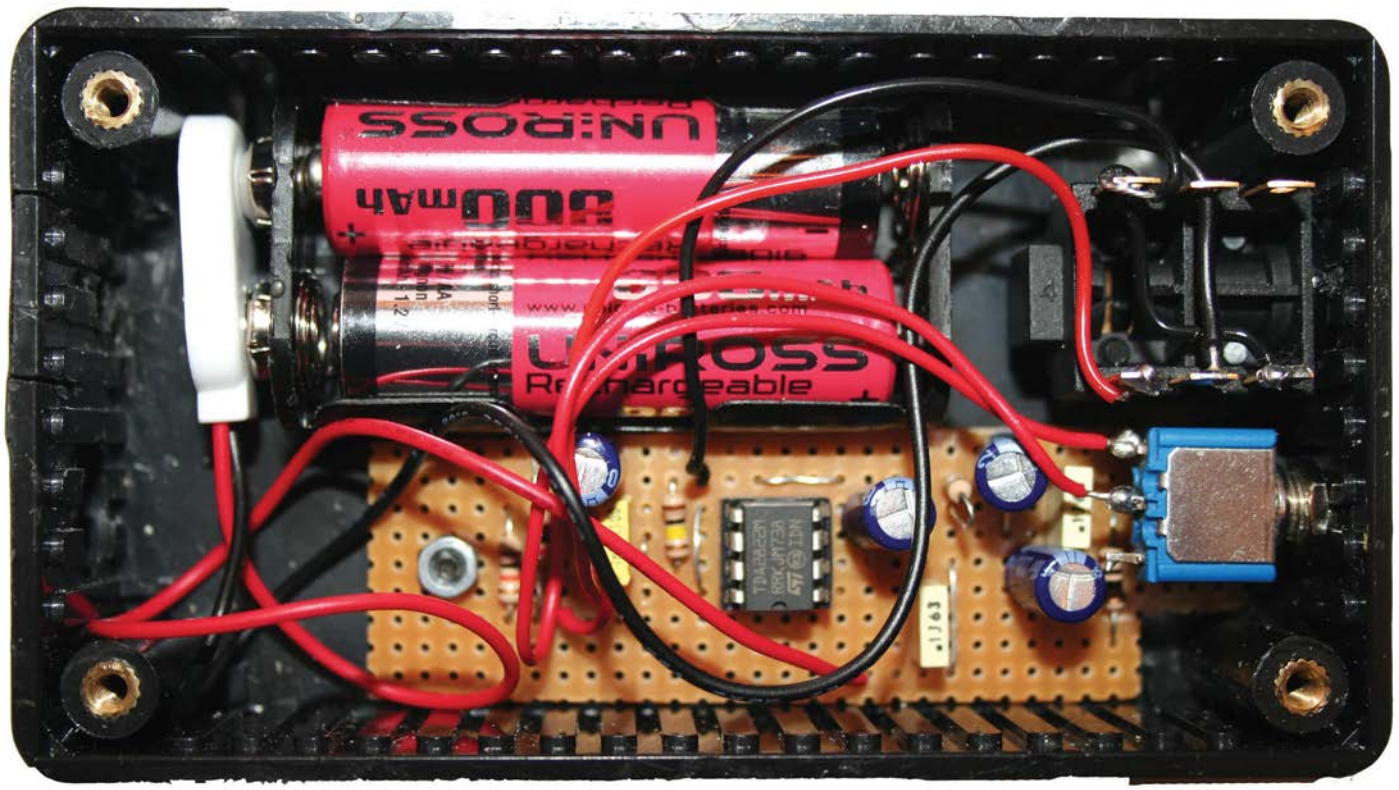
PARTS, LINKS & BREAKS MATRIX

Here's our parts matrix. The code denotes the strip by letter and the hole by number. Note that the letter 'I' is omitted. Parts sequence goes from left to right referred to matrix picture view

1. JM23A (3.5mm jack skt): E3 / G1 / J3
2. M10R (10 ohm resistor): B5 – G5
3. DT98G (100 nF poly cap): F7 – H7
4. VH41U (220uF cap): D8 (+) – E8 (-)
5. VH41U (220uF cap): F9(+) – J9(-)
6. M10R (10 ohm resistor): G11 – H11
7. DT98G (100 nF poly cap): B12 – D12
8. VH41U (220uF cap): E14 (+) – G14 (-)
9. NJ38R (driver i.c.): pin 1 – D17, pin 4 – G17, pin 5 – G20, pin 8 – D20
10. M100K (100Kohm resistor): E23 – H23
11. DT92A (1nF poly cap): E24 – G24
12. VH41U (220 uF cap): H25 (-) – J25 (+) 13. M1K (1Kohm resistor): C26 – J26
14. M10K (10 Kohm resistor): C27 – G27
Off-board components
15. BW79L (6.3mm jack skt): Tip terminal – wire to E25. Tip ground/sleeve terminal common – wire to H21
16. FH100A (mini toggle): centre terminal – wire to C28. End terminal – wire to G28
17. NE19V (battery clip): red wire to A12, black wire to BW79L ring terminal
Links matrix: A11 – E11 G16 – H16 D21 – G21 E22 – F22
Breaks matrix: C20 / D18 D26 / E9 E18 E26 / F18 F26 / G18 / H15 / J11



(2) All the soldering done. Make sure to avoid jumping any tracks with stray solder



3 Inside the box – doesn't look too complicated does it!

sharp-nosed pliers or side cutters, nibble out one corner of the board to clear the corner post of the case (according to the matrix, holes 1 to 4 in strips A to C should be removed). Before attempting this, we'd advise you to score the corner with a straight edge and a hobby knife to prevent accidentally overshooting with the nibbling tool.

Drill a 3.5mm hole in the board, using hole E 29 as the centre. Use the same drill as a spot-face cutter to create breaks in the tracks at the points listed in the Breaks Matrix shown in the box below. Now fit the resistors across the board, passing the wires through the holes specified in the Parts Matrix (note that one of the resistors stands up on end), trim the wires under the board, and use the off-cuts to make the links. Fit the links across the board as specified in the Links Matrix (again shown in the box below), bend them back along the strips and trim them to about 2mm, then solder them to the strips. Take care not to solder-bridge any strips: likewise with the resistors. Fit the IC, whose pins should straddle the row of four broken strips D – G, holes 17 – 20; likewise the mini-jack, whose terminals should appear through E3, G1, and J3. Fit the capacitors and the wiring from the jack, switch and battery clip, as per the Parts Matrix. Note that battery-clip negative (black) goes direct to the middle 'ring' terminal of the three-pole input jack, and that the right-handmost 220uF capacitor is oriented inversely to the three others.

Finally, push the nose of the mini-jack through the 6.5mm hole nearest the roof of the box, and mark the case through the hole you made in the board. Drill through, and pass a short M3/6BA screw through the case and the board, using a nut to fix the board down to the case. You may like to include a small washer or spacer under the board to avoid bending stress with the nut tightened. Now fit the 6.3mm jack socket, with one spacer inside the case, and the switch, oriented with its throw horizontal. Fit two AA cells to the battery carrier and connect the clip. The carrier should fit snugly enough to avoid any need for further fixing with the lid in place. Connect your favourite phones and guitar, and you should get good clear sound at a reasonable level on one switch setting and much louder on the other setting.

We had so much fun with this little box that we're working on a more sophisticated version. This will have mixable mic and guitar channels and we're looking at a bit of stereo echo too.

*Please note: This article was first published some years ago, however, all parts are still currently available from Maplins, with the same part numbers, with the exception of the TDA2822M amp driver (the rather vital black box in the centre of the board) which it no longer stocks. Happily these components can still be bought on ebay or from sites like www.lightinthebox.com.

WHAT YOU NEED

Part numbers and prices are taken from the 2015 Maplin website

QTY	PART NO	DESCRIPTION	PRICE
1	N70BQ	Project box (Hammond 1591B)	5.29
1	JP47B	Stripboard 2939	3.49
1	JM23A	3.5mm stereo jack skt.	1.59
1	BW79L	6.3mm 3-pole jack skt	1.99
1	FH00A	SPDT mini-toggle switch	2.79
1	NJ38R	TDA2822M driver i.c.	2.91*
1	NE19V	Battery clip	1.49
1	YR60Q	2 x AA battery box w/PP3 clip terminal	1.59
4	VH41U	220uF 16v electrolytic caps	2.36
2	DT98G	100nF poly caps	0.98
1	DT92A	1nF poly cap	0.59
2	M10R	10 ohm resistor	0.78
1	M1K	1Kohm resistor	0.39
1	M10K	10Kohm resistor	0.39
1	M100K	100Kohm resistor	0.39
		TOTAL	£27.99

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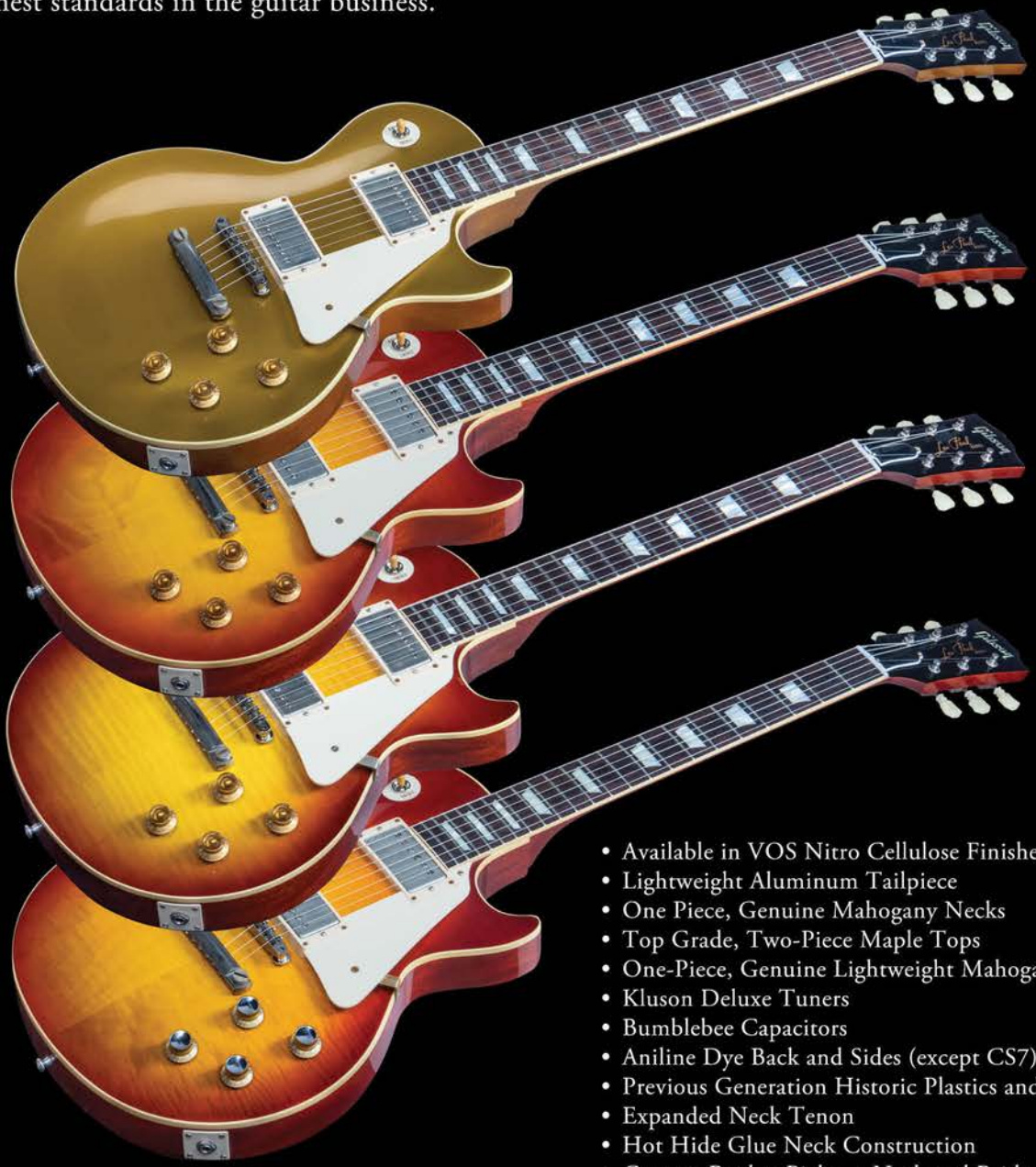
BRIAN MAY'S RED SPECIAL

In 1964 Brian May and his electrical-engineer father built a guitar. Driven, most likely, by the cost of top-flight instruments of the day and the thrill of simply rising to the challenge, the result was to have a significant impact on the world of rock. The Red Special provided May's signature tone for Queen's recordings and is in service to this day. It could well be the ultimate DIY guitar and it's also the inspiration for our electric guitar building project in this very magazine. The Red Special symbolises just what can be achieved with a few tools, a little knowledge and a guitar inclined imagination. We sincerely hope this magazine will help put you on the road to similar feats.

Photo: Mike Prior

CS Series

The Ultimate 1950's Style Hand Crafted Player's Les Paul

The new CS Series from Gibson Custom is where hand-crafted excellence meets ultimate Les Paul performance. For players in pursuit of authentic vintage Gibson tone, feel and craft, Gibson Custom's CS Les Paul range is the perfect destination. Offering a performance focused Les Paul of Historic lineage in a variety of 50's inspired, beautifully crafted guitars, each CS model delivers the authentic looks, the feel and most importantly, the tone of the legendary Les Paul guitar, hand-crafted to the highest standards in the guitar business.

- Available in VOS Nitro Cellulose Finishes
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- One-Piece, Genuine Lightweight Mahogany Backs
- Kluson Deluxe Tuners
- Bumblebee Capacitors
- Aniline Dye Back and Sides (except CS7)
- Previous Generation Historic Plastics and Knobs
- Expanded Neck Tenon
- Hot Hide Glue Neck Construction
- Custom Bucker Pickups-Neck and Bridge
- Historic Truss Rod Assembly (no tubing)
- 2015 Gibson Custom Die Cast Rhythm/Treble Switch Cavity Cover

The Guitar DIY Bible 2015

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